Exam. Primer Series.

Clarkson's Problems in Arithmetic.

TEACHER'S EDITION.

W. J. Gage & Co.'s Examination Primer Series.

PROBLEMS IN ARITHMETIC

FOR

PUBLIC SCHOOLS

INCLUDING THE

Entrance Examinations,
Public School Leaving Examinations,
and Primary Examinations.

BY

C. CLARKSON, B.A.,

Principal of Seaforth Collegiate Institute.

Teachers' Edition.

W. J. GAGE & COMPANY,

TORONTO.

PREFACE.

THE teacher of an ungraded school has to solve a difficult question when he comes to distribute his available time among a number of classes at all stages of progress below the *Public School Leaving Examination*. This little volume has been compiled to assist such teachers in economising time by setting senior pupils to teach themselves Arithmetic with a minimum of oral assistance. In view of *the proposed increase in the difficulty in the Entrance and P. S. Leaving Examinations* the full set of Entrance Examination Papers from the beginning furnishes the best possible preparation for ensuing examinations. *Learn to pass the examination by passing the examination*, is the best advice that can be given. Accordingly this collection of questions contains a few carefully selected REVIEW QUESTIONS, which are intended to be worked in the order in which they are given. Next follow THE ENTRANCE PAPERS FROM THE BEGINNING in 1873 to date. These papers are best utilized by taking question No. 1 through the whole set, then question No. 2 in each set, etc., for the papers are generally somewhat graded from the beginning to the end. Then follow the P. S. LEAVING PAPERS and a few sets of like difficulty. This is the only complete collection of these papers in print. THE TEACHERS' EDITION contains answers to all the questions and SKELETON SOLUTIONS, which enable the teacher to correct his pupil's work in the shortest possible time, or enable the senior pupil to learn for himself how to solve the problem, thus leaving the teacher free to devote more time to literature, composition, reading, etc., in which subjects our schools are so generally deficient.

To add to his perplexities the public school teacher in some rural sections is expected to prepare two or three pupils for the Primary Examination every year. To help this worthy class of teachers, who

are compelled to make extraordinary drains on health and strength by doing one or two hours over-time every day, the FULL SET OF PRIMARY OR THIRD CLASS PAPERS down to date is given. The questions are roughly graded, so that the best plan of attack is to work No. 1 in each paper throughout, then No. 2, etc., until the pupil is preprared to do a paper in full against time. THE TEACHERS' EDITION contains a complete set of answers to the whole and SKELETON SOLUTIONS to all the questions requiring them. It is hoped that teachers will try THE LABORATORY PLAN, which has proved a triumphant success in other branches. In this plan the material to be investigated—in this case the sets of problems—is placed before the pupil and he receives directions how to set to work. He also receives books, apparatus, etc., and is told how to make use of them. Thus equipped he is left to his own resources as much as possible. After going rather slowly for a week or two he begins to depend on himself and learns to teach himself with the least possible assistance from his teacher, whose duties become largely of an advisory kind.

This plan has been fully tested in Arithmetic with great success. The questions here given without the answers furnish the matter to be investigated. If the pupil can write out full and explicit solutions he needs no help and receives none. If he fails after due trial the *Skeleton Solution* gives him assistance at the discretion of his teacher, or it enables the teacher to point out in a moment the vicious step in the calculation, so that time is economised and the overpressure of examination work is relieved to an appreciable extent.

C. C.

Seaforth. Coll. Inst., January, 1893.

CONTENTS.

INTRODUCTION.

I. **The Tendency of Recent Examinations** has been towards reducing theory to a minimum and towards clothing the few, simple principles of pure arithmetic with circumstances and details in the form of problems and applied questions. It is easily observed that our examinations in arithmetic consist largely of problems containing in disguised form some one or more applications of the fundamental abstractions of arithmetic. The effect of this is two-fold. It prevents very effectually the mere memorizing of dead rules without clear apprehension of their meaning; and on the other hand it tempts teachers to pass lightly over pure arithmetic and to spend most of their available time in the solution of problems. Indirectly, therefore, the tendency is to neglect mechanical skill, accuracy, and rapidity in performing fundamental operations, and to exalt the power of analysing applied questions and problems.

II. **Mechanical Skill vs. Analytic Power.**—Of these two acquirements the latter is in all respects the more important as a discipline of the mind; yet in practical life the former is of very great importance; and, we may add, that for the purpose of doing a given amount of work in a limited time at an examination, quickness, promptness of action, and a knowledge of the shortest methods are equally as necessary as accuracy of thought. Since we have examinations as a kind of necessary evil, it is well to consider carefully how best to prepare pupils for these ordeals.

III. **The Four Simple Rules** should receive very particular attention and rapidity should be cultivated by every ingenious artifice and stimulated by appeals to every proper motive. Constant reviews, matches, puzzle questions, rewards, special privileges, etc., will readily suggest themselves. The main point is to place in some way a very special emphasis on the importance of unerring accuracy and of great rapidity in all combinations of the four simple rules as essential to success at the examinations. In many transatlantic schools this mechanical skill is the strongest feature of the teaching. A careful observer reports that in an Edinburgh school some of the pupils "will multiply such a line of figures as 7,685,928,165,487,938,764 by 7, 8, or any other figure, in *less than the sixth part of a minute.* From such a line they will subtract another of the same length, in the ordinary way, in *about seven seconds.* In simple addition they will sum up seven lines of eight figures each, in the ordinary way, in *less than one-third of a minute*, and, if allowed to perform the operation while the question is dictating, in about *three seconds.*"

The gain in time is not the only gain, for with rapidity in the mechanical work, pupils acquire energy, decision, and quickness of mind that are of great practical value in all lines of study. From the earliest stages, *work at high speed* should receive constant care, and the best drill is found in pure arithmetic with tolerably large numbers; whereas, the most useful drill in analysis deals with small numbers and emphasises the intellectual side of the problem. There are numerous simple expedients by which the busy teacher can easily supply practice in long addition, multiplication, subtraction, division, etc., without being obliged to work every question in order to test the pupil's result. All recent papers assume that pupils can add up an ordinary ledger column, both vertically and horizontally, without error and with considerable celerity, and this tendency is likely to increase, for in practical life the greater part of the arithmetical calculations are of this character. The ability to multiply ten figures by ten figures, and divide the product back again should be one of the tests for promotion to the fourth class.

IV. **Mistakes in Subtraction** give rise to more errors than mistakes in multiplication, addition, and division combined. It is, therefore, a decided advantage to perform subtraction as a species of addition, and it is much easier for the pupil to learn it in that way. Thus, instead of saying five from seven leaves two, it is possible to state the question five and *how much?* makes seven? In long lines we thus proceed as if proving the result by additions, and no new rule has to be taught. Example:—

6325464
895493
5429971

3 and? **1** are 4; 9 and? **7** are 16; 5 and? **9** are 14; 6 and? **9** are 15; 10 and? **2** are 12; 9 and? **4** are 13; 1 and? **5** are 6. In each case the figure is set down as the answer to the mental question is thought. The mystery of "borrowing and paying back" is avoided. This method enables the pupil to do long division very rapidly with half the usual figures by combining multiplication and subtraction. Example:—

13887
4064) 56438971
15798
36069
35577
30651
2203

Write the quotient over the dividend, when convenient, to assist the eye, and say once 4 and? **nine** are 13 (set down 3 and carry one); once 6 are 7 and? **seven** are 14; once 0 is 1 and? **five** are 6; once 4 and? **one** are 5. Bring down 8. Three times 4 are 12 and? **six** are 18; three times 6 are 19 and? **zero** are 19; three times 0 is 1 and? **six** are 7; three times 4 are 12 and? **three** are 15. Bring down 9, etc. Pupils learn this in one lesson, and it conduces to accuracy and rapidity as experience abundantly proves, and the result can be tested by casting out nines more easily than with the subtrahends fully written out.

V. **The Extended Multiplication Table** is of enormous service at written examinations, and in business life it is equally important. Experience soon teaches accountants and salesmen the necessity of knowing the table up to 16 or 20 times at least. Five minutes a day for five weeks will give a third class full mastery of the table to the end of 16 times 16, and the same time will carry a fourth class to 25 times 25, provided that the pupils construct their own table by successive additions and subtractions. Applied questions come in later to fix the multiples in the memory, but they are a hindrance in the work of *learning* the table. It saves a vast amount of time in written papers if the pupil can multiply, divide, or cancel with numbers as high as 25, and in this connection the squares and the cubes of simple numbers ought to be learned as they occur.

VI. **Testing and Verifying the Work** is a matter of supreme importance in business, architecture, surveying, etc., and all the simple means of doing this are of eminent service at written examinations. When the pupil reaches the third class he ought to be able to test multiplication, division, and addition by "*casting out nines*" with great ease and rapidity, so that he may have confidence in his results as the work proceeds. He should also know as soon as possible how to verify his solution of a problem by check calculations to test its consistency with the data. One correct answer on a paper will usually count more marks than three inaccurate results even when the method of solution is perfect.

VII. **Indicating the Work** first and performing it afterwards is an artifice of first-rate importance on examination papers. All written work can be done most quickly and accurately by separating as clearly as possible the analysis of the problem from the mechanical operations necessary to obtain the correct result. The examiner can judge in a moment whether the candidate understands *how* to work the question and can award him marks for the correct analysis, whereas if the operation is not properly indicated and the final result is wrong the candidate receives nothing or some merely nominal mark. It is not always possible

to make this separation complete at one stage, but the pupil must be accustomed to set down the ground plan of his work first and make sure that he has done the reasoning correctly, otherwise he will be attempting to do two different things at the same moment. **Factoring** and **Cancelling** must be learned as early as possible, so that the work may be shortened and simplified. Thus, in solving the following question a little skill in factoring numbers actually reduces the mechanical part of the work to zero :—

"A speculator borrowed \$5,000, and immediately invested it in land. Six months afterwards he sold the land for \$7,500 on 12 months' credit with interest. Find the speculator's profit, supposing he pays back the \$5,000 in 18 months after he borrowed it, all moneys being worth 6 % per annum simple interest."

Solution.—Sum received for land = \$7500 (1·06),
Sum paid back = \$5000 (1·09),
Profit = 7500 (1·06) − 5000 (1·09),
= 7500 (1·06) − 5000 (1·06) − 5000 (·03),
= 2500 (1·06) − 2500 (·06) = \$2500.

Example 2. Find the area of a triangle whose sides are 760, 950, and 570. Applying the ordinary rule,

$$\text{area} = \sqrt{(1140 \times 380 \times 190 \times 570)}$$
$$= 100\sqrt{(114 \times 38 \times 19 \times 57)}$$
$$= 100 \times 19 \times 19\sqrt{(6 \times 2 \times 1 \times 3)}$$
$$= 100 \times 19 \times 19 \times 6 = \text{etc.}$$

VIII. **The Utility of the Simple Arithmetical Equation** can scarcely be exaggerated as a means of clearly mapping out the reasoning in all kinds of solutions. Every problem and question involves the equation. The addends taken together = the sum, the minuend − the subtrahend = the difference ; the multiplicand taken as an addend as many times as the multiplier contains units = the product ; the quotient × the divisor + the remainder = the dividend ; the number of the articles × the price of one article = the cost ; the principal × the rate per \$ × the years = the interest, etc., etc. Perhaps no single omission in the ordinary text-books has done so much harm to the learner as the

omission of a chapter on the use of the simple arithmetical equation, which is within the power of the youngest pupil, as it involves nothing more than the simple axioms that are fundamental beliefs. Full and systematic solutions expressed in the form of equations dispel half the mystery that usually hangs over arithmetic. Very often the use of the equation, and a little skill in factoring numbers and cancelling, shorten the work by more than one-half, and every minute saved on an examination paper means two minutes gained. Abundant examples of this are given in the **Skeleton Solutions** of the following papers given in *The Teachers' Edition* of this little book and in the **Type Solutions** prefixed to the last section.

IX. **Clear, Definite Aims** are a prime requisite to success at any examination. The student must know what he is expected to perform, and he must be taught how to do it at the least expenditure of time and labor. A careful study of the papers in this book will give a practical knowledge of the standard that prevails in Ontario, and will enable any pupil of ordinary intelligence to know definitely when he is able to cope with the succeeding paper. The best way to learn swimming is to plunge into the water; and the best way to prepare for an examination is to plunge into the examination papers and struggle through them some thrice.

PROBLEMS IN ARITHMETIC

FOR PUBLIC SCHOOLS.

Review Questions.—Addition.

EXERCISE I.

(1) Add together 8,963, 9,572, 43,958, 12,788, 24,293, 43,986, 2,543, 8,520, 488 and 6,304.

(2) In question (1) take the sum of the digits of each number. divide each sum by 9; take the sum of the remainders thus found and divide it by 9. Show that the remainder so found is the same as the remainder found by taking the sum of all the numbers and dividing the sum of its digits by 9.

(3) Ascertain by "*casting out the nines*" whether 133,330 is the sum of the following numbers, correcting it if necessary:—19,348, 10,195, 18,919, 40,914, 9,665, 12,190, 2,187, 12,424, 3,985, 2,502.

(4) Add together 19,359, 17,945, 19,077, 5,417, 2,897, 15,670, 7,501, 6,771, 205, 3,285; and test the accuracy of your result by "*casting out nines.*"

(5) 25,010, 21,555, 31,932, 36,567, 21,944, 8,345, 19,482, 2,657, 5,212, 1,488. What is the excess of the sum of these numbers over 170,000?

(6) The average number of people at a ferry was 1,648 for the whole week. For Sunday and Monday it was 1,239, for Thursday, Friday and Saturday 1,842. What was the average number per day for Tuesday and Wednesday?

(7) Add together the products of each pair of the numbers. 150, 225, 375, and find the difference between this sum and the product of all three numbers.

(8) The population of ten cities are as follows:—65,539, 76,306, 156,844, 182,296, 196,352, 233,418, 242,731, 213,606, 358,989, 211,190. Find the total and the average.

(9) Show that 1,500,090 is less than the sum of 161,415, 132,329, 98,127, 174,192, 140,871, 62,486, 90,334, 66,552, 73,148, 94,219, 99,928, 104,301, 36,631, 44,064, 46,060, 13,977, 30,350, 42,210. Test your work and give the correct result.

(10) Find the aggregate of the following debts as shown by the ledger totals in a merchant's books:—$42.17, $36.24, $18.42, $10.71, $194.30, $347.16, $40.00, $12.94, $86.73, $271.19, $103.07, $500.50, $7.59, $11.44, $81.92, $110.10, $107.09, $207.16, $97.20, $21.77, $150.15, $427.26, $316,42, $114.64.

Exercise II.

(1) Find the sum of all the numbers of three digits that can be made with the figures 3, 6, 9.

(2) The populations of five townships are 1,236, 452, 364, 516 and 3,430 respectively, and the average population of the six townships in the county is 1,256½. What must be the population of the sixth township?

(3) What is the sum of 45 millionths, 45 thousandths, 45 hundredths, 45 tenths, and 45 units?

(4) The receipts at a ticket office for twenty-four weeks were as follows:—$1,132.16, $327.40, $177.66, $94.57, $157.16, $27.96, $18.19, $276.44, $137.89, $372.22, $410.10, $56.00, $63.41, $48.50, $709.08, $320.00, $271.78, $152.60, $39.46, $71.32, $173.26, $427.90, $194.32, $506.76. The agent returns the amount as $6,160.24. The auditors detect the error. How much must the agent remit to rectify the mistake?

(5) A collector receives ten payments but forgets to record the eighth. He finds on hand cash $422.10, and his book shows nine payments of $137.21, $142.45, $23.56, $24.06, $24.99, $12.75, $8.56, ——, $36.40, and $8.92. Find the sum omitted, and complete the record.

(6) The head office of an Insurance Company has nine agents at work who remit the following sums for ten weeks, viz.:— **1st week,** $89.63, $193.48, $193.59, $250.10, $181.50, $93.50,

$184.77, $90.80, and $174.49; **2nd week,** $95.72, $101.95, $179.45, $215.55, $360.95, $100.75, $180.90, $91.35, $66.53; **3rd week,** $439.58, $189.19, $190.77, $319.32, $162.28, $95.05, $35.03, $194.25, $42.75; **4th week,** $127.88, $409.14, $54.17, $365.67, $97.35, $36.57, $85.77, $90.26, $182.15; **5th week,** $242.93, $96.65, $28.97, $219.44, $222.79, $47.18, $38.91, $64.95, $47.25; **6th week,** $439.86, $121.90, $156.70, $83.45, $121.20, $13.50, $234.73, $96.87, $61.05; **7th week,** $25.43, $21.87, $75.01, $194.82, $72.80, $62.59, $5.04, $9.13, $97.20; **8th week,** $85.20, $124.24, $67.71, $26.57, $129.80, $57.25, $45.25, $8.62, $21.65; **9th week,** $4.88, $39.85, $2.05, $52.12, $35.35, $88.90, $44.25, $6.15, $21.52; **10th week,** $63.04, $25.02, $32.85, $14.88, $24.69, $29.57, $48.69, $13.14, $16.89. Find the total amount received, the amount remitted by each agent, and the amount received each week. Arrange the whole in the form of a table for ready reference.

(7) Arrange the following sums in a single ledger column. Find the total by *reading up* each line of figures, thus, 4, 5, 10, 11, 19, 24, etc.:—$14,763.84, $33,276.90, $47,061.39, $18,242.76, $47,364.96, $8,410.31, $5,724.27, $56,317.66, $81,742.73, $22,431.27, $40,163.55, $32,189.60, $7,063.21, $3,451.09, $9,200.00, $1,807.36, $56,768.72, $63,024.27, $36,180.45, $90,807.08, $28,763.81, $37,196.75, $4,230.61, $3,719.84. Test your result.

(8) At a bank the cash receipts and payments for a week were as follows:—Monday, receipts £1,073 16*s.* 4*d.*, payments, £562 18*s.* 9*d.*; Tuesday, receipts, £987 15*s.* 3*d.*, payments, £739 17*s.* 5*d.*; Wednesday, receipts, £854 11*s.* 11*d.*, payments, £947 16*s.* 11*d.*; Thursday, receipts, £9,376 19*s.* 2*d.*, payments, £1,073 15*s.* 3*d.*; Friday, receipts, £786 17*s.* 6*d.*; payments, £693 0*s.* 7*d.*; Saturday, receipts, £1,240 0*s.* 10*d.*, payments, £892 11*s.* 1*d.* What was the excess of the total receipts over the payments during the week? Arrange your figures in tabular form for reference.

(9) Rule lines to form a square, divide each side into 11 equal parts, rule lines so as to make 121 spaces, each large enough to hold a number of four digits. In these spaces place the following numbers in order, beginning at the upper left hand corner and filling up the horizontal lines:—2,016, 4,212, 1,656, 3,852, 1,296, 3,492, 936, 3,132, 576, 2,772, 216; 252, 2,052, 4,248, 1,692, 3,888, 1,332, 3,528, 972, 3,168, 612, 2,412; 2,448, 288, 2,088, 4,284, 1,728, 3,924, 1,368, 3,564, 1,008, 2,808, 648; 684, 2,484, 324, 2,124, 4,320, 1,764, 3,960, 1,404, 3,204, 1,044,

2,844; 2,880, 720, 2,520, 360, 2,160, 4,356, 1,800, 3,600, 1,440, 3,240, 1,080; 1,116, 2,916, 756, 2,556, 396, 2,196, 3,996, 1,836, 3,636, 1,476, 3,276; 3,312, 1,152, 2,952, 792, 2,592, 36, 2,232, 4,032, 1,872, 3,672, 1,512; 1,548, 3,348, 1,188, 2,988, 432, 2,628, 72, 2,268, 4,068, 1,908, 3,708; 3,744, 1,584, 3,384, 828, 3,024, 468, 2,664, 108, 2,304, 4,104, 1,944; 1,980, 3,780, 1,224, 3,420, 864, 3,060, 504, 2,700, 144, 2,340, 4,140; 4,176, 1,620, 3,816, 1,260, 3,456, 900, 3,096, 540, 2,736, 180, 2,376. Now add the vertical columns, the horrizontal columns, and the two diagonal columns. Do this 10 times and record the time required for each operation.

NOTE.—In commercial life Addition is by far the most important part of Arithmetic, and the pupil is recommended to construct gymnastic exercises like No. 9 and do them against time. Let each member of the class furnish one in turn and let the time required be recorded until the addition of vertical and horizontal lines of figures can be performed mechanically at high speed.

Review Questions.—Simple Rules.

EXERCISE III.

(1) Add together 804,959, 186,402, 700,077, 9,450,068, 20,047,300; subtract from the sum 670,076, and divide the remainder by 87.

(2) Find the sum, the difference, and the product of 1,234,568 and 4,321,089.

(3) In a question in division the dividend was 31,884,740 and the quotient was 40,930; find the remainder.

(4) Divide the product of 999,999 and 1,955 by the continued product of $37 \times 13 \times 17 \times 7 \times 23$.

(5) Find what number subtracted from the one five hundred and eighty-third of the product of 31,472 and 974 will leave exactly 100.

(6) Multiply 129,847 by 468, commencing with the figure 6, next by 4, and lastly by 8.

(7) Add together 567, 496, 341, 827, beginning at the hundreds, next the tens, lastly the units.

(8) Subtract 34,876 from 72,093, and explain every step of the process.

(9) Divide 550,974 by 1,472 and explain fully the operation.

(10) Multiply 234,567,891 by 118,813,212 using altogether only seven lines of figures in the operation.

Review Questions.—Multiplication.

EXERCISE IV.

(1) The product of two numbers is 760,069,388, and one of the numbers is 26,078. What is the quotient when their sum is divided by 36?

(2) The divisor is 19 times the quotient and 38 times the remainder, which is 212. Find the dividend.

(3) Multiply 4,327 by 814.

(4) In Question 3 take the sum of the digits of the multiplicand (4,327), divide that sum by 9 and set down the remainder; take the sum of the digits of the multiplier (814), divide the sum by 9 and set down the remainder; multiply these two remainders together and divide the product by 9, set down this remainder and *observe that it is the same* as the remainder obtained by "*casting out the nines*" from the product.

This test for multiplication is of immense practical value, and the pupil is strongly recommended to apply it to every case of multiplication he performs. It is not absolutely infallible, but in actual practice it will not fail once in 10,000 times to point out an error.

NOTE.—The teacher should explain the rapid method of performing the process of casting out nines and encourage the pupil to apply it at every stage of his work.

(5) Multiply 123,456,789 by 987,654,321, and test the result by casting out the nines.

(6) Multiply 57,298,492,692 by 700,809,050,321, and test your answer to detect any error in the work.

(7) There is a star whose distance from the earth is 574,585,614,865 miles, as nearly as can be calculated. Astronomers have noticed another star which is 2,837,154,309 times more distant than the first. Express in miles the distance of the second star from the earth.

(8) Construct a multiplication table for yourself from 13 times 2 to 19 times 19 and learn it by heart, one column to be learned each day in 15 minutes.

(9) Multiply 234,578 by 18 in one line of figures and test your answer.

(10) Multiply 924,846 by 95, using the factors 5 and 19 so as to save addition.

(11) Find the continued product of 12, 17, and 19, using the extended table of question 8.

(12) The quotient is 17 when 9,281 is divided by a certain number and the remainder is 373. What is the unknown divisor?

(13) Arrange 15 dots in rows, 3 dots in each row; also arrange 15 dots in rows, 5 dots in each row, and from this show (*a*) that $5 \times 3 = 3 \times 5$; and (*b*) that in both cases the multiplier is an abstract number denoting *the number of times* that some other number is to be repeated as an addend.

Review Questions.—Subtraction and Division.

EXERCISE V.

(1) Subtract 123,456,789 from 987,654,321 and prove the result by addition.

(2) Subtract 584 from 721 and prove the result as you proceed thus, 4 and ?—7 make 11; 9 and ?—3 make 12; 6 and ?—1 are 7. Apply this method to Question 1.

(3) Write down ten examples in subtraction, each containing ten figures. Do these examples over and over against time until you can do them in ten seconds each.

(4) Write down ten examples as in Question 3 and obtain the correct answers in one minute.

(5) Take the number 1,234,567,890 and divide it by 12, then by 13, then by 14, etc., by 19. Prove each division by multiplication. Go through this gymnastic ten times and keep a record of the number of minutes required in each trial to do these 13 divisions and 13 multiplications. Endeavor to break your record at each trial.

(6) Multiply 584 by 721 and prove the result by casting out nines. Divide the product by 584 and apply the same test to your division. Also divide the product by 721 and apply the same test.

(7) Divide 24,533,279 by 432. Prove the result by subtracting the remainder, 431, from the dividend, and observing that the remainder, on casting out nines, gives the same figure 0 as the product of the remainders left on casting out nines from divisor and quotient.

(8) Find out without actually dividing whether 8,534,589 is contained 20,303 times with remainder 8,534,579 in the number 173,286,295,046.

(9) Observing that $432 = 6 \times 8 \times 9$, work Question 7 by short division, using 6, 8 and 9 as successive divisors, and obtain the correct remainder.

(10) Take 24,533,279 pounds of tea. Put 6 pounds in each package, 8 packages in each parcel, and 9 parcels in each box, and tell how many pounds of tea are left out of the 56,789 boxes required. Observe that there are 8 parcels. 7 packages, and 5 pounds remaining, and hence deduce the rule for finding the true remainder in Questions 9 and 10.

(11) Divide 4,796,292 by 105 using factors and find the correct remainder, 102.

(12) Show that 285 is not the correct remainder when 8,765,348 is divided by $6 \times 7 \times 11$.

(13) Prove that 58,679 is an exact divisor of 2,808,332,-109,244.

(14) Distribute $5,191,477,917,688,477,236 equally among 172,814,412 cities and give the share of each. Test your result.

Exercise VI.

(1) $153 = 9 \times 17$; $144 = 9 \times 16$; what is the H.C.F. of 153 and 144? Express their L.C.M. in factors. Show that the L.C.M. is equal to their product divided by their G.C.M.

(2) What is the greatest number that will divide 32 with remainder 5? What is the greatest number that will divide 24 with remainder 6? What is the greatest number that will divide 32 and 24 with remainders 5 and 6 respectively?

(3) What is the greatest number that will divide 68,130 and 107,275, leaving remainders 27 and 49 respectively?

(4) The product of two numbers is 24, their H.C.F. is 2; find their L.C.M.

(5) Resolve 1,287 and 6,281 into prime factors, and find their L.C.M.

(6) Multiply both numerator and denominator of $\frac{1}{2}$ and $\frac{1}{3}$, so that they may have the same denominator and still retain their present values.

(7) If $\frac{1}{2} = \frac{5}{10}$, and $\frac{3}{5} = \frac{6}{10}$, what is the L.C.M. of $\frac{1}{2}$ and $\frac{3}{5}$? What is the L.C.M. of \$5 and \$6?

(8) Find the L.C.M. of $1\frac{5}{7}$, $1\frac{1}{14}$, $\frac{20}{161}$.

(9) Find the G.C.M. of $2\frac{2}{5}$, $2\frac{1}{7}$, $\frac{21}{56}$.

(10) Reduce to lowest terms—$\frac{3}{4}$, $\frac{5}{8}$, $\frac{7}{8}$, $\frac{9}{10}$, $\frac{11}{15}$, and hence find their sum.

Exercise VII.

(1) Find the H.C.F. and the L.C.M. of 17,725, 554, 1,054,872, and 2,406,096.

(2) Bring $\frac{144}{150}\frac{85}{48}\frac{23}{8}$ to its lowest terms.

(3) Reduce $\frac{6}{7}$, $\frac{8}{9}$, $\frac{12}{17}$, and $\frac{16}{19}$ to the same common numerator and hence point out the greatest fraction.

(4) Reduce the product of $\frac{33}{51}$, $\frac{85}{112}$, $\frac{189}{207}$, and $\frac{23}{36}$ to its lowest terms.

(5) Divide the sum of $\frac{6}{7}$, $\frac{5}{3}$, $\frac{9}{14}$, $\frac{11}{6}$ by the difference between $\frac{4}{5}$ and $\frac{7}{9}$.

(6) Divide $1 - (\frac{1}{2} + \frac{1}{3} + \frac{1}{2\frac{1}{4}})$ by $1 - (\frac{1}{2} \times \frac{1}{3} \times \frac{1}{2\frac{1}{4}})$.

(7) Add together $\frac{3}{16}$, $\frac{13}{40}$, $\frac{231}{250}$, $\frac{9}{625}$. Express the fractions as decimals and find their sum.

(8) What number multiplied by $35\frac{1}{8}$ will be less by $5\frac{11}{64}$ than the sum of $3\frac{7}{8}$ and $5\frac{11}{16}$?

(9) What quantity must be added to the difference between $5\frac{7}{8}$ and $9\frac{1}{12}$ so that when the sum is multiplied by $\frac{24}{5}$ the product may be 28?

(10) Simplify $\dfrac{9\frac{1}{2} \div 6\frac{1}{3}}{9\frac{1}{2} - 6\frac{1}{3}} \div \dfrac{16\frac{7}{8} \div 11\frac{1}{4}}{16\frac{7}{8} + 11\frac{1}{4}} \times 17\frac{9}{14}$.

Review Questions.—Miscellaneous Examples.

Exercise VIII.

(1) Divide $16 \times 72 \times 45 \times 21$ by $27 \times 32 \times 12 \times 35$.

(2) Divide $213 \times 84 \times 190 \times 264$ by $30 \times 56 \times 36$.

(3) Divide the sum of ·075 and ·0075 by the difference between 7·5 and ·75.

(4) What is the product of :—

$$\frac{9}{38\frac{1}{4}}, \quad \frac{174\frac{1}{9}}{196\frac{1}{4}}, \quad \frac{44\frac{5}{8}}{16\frac{1}{3}}, \text{ and } \frac{40\frac{8}{11}}{36\frac{4}{7}}?$$

(5) Multiply the sum of the quotients in the following cases by 25·25 :—270 ÷ 4,000; 1,307 ÷ ·008; ·0103 ÷ ·04; 70·306 ÷ ·5; 3·78 ÷ 200; ·04735 ÷ ·0005; 30 ÷ ·004; 903 ÷ 30,000.

(6) If Europe has 3,860,253 sq. mi. and 295,803,933 inhabitants, and Asia has 17,112,526 sq. mi. and 782,129,318 inhabitants, which continent has the greater number of people to the square mile, and how many more?

(7) If $8\frac{3}{8}$ oz. of bread cost $6\frac{1}{2}$c. when wheat is \$1.25 per bush., how many oz. of bread ought to be sold for 25c. when wheat has fallen to $87\frac{1}{2}$ cents per bush.?

(8) How many cubic feet of earth must be removed to enlarge a cellar 26 ft. long, 18 ft. wide, and 7 ft. deep, so as to make it 28 ft. long, 21 ft. wide, and 8 ft. deep?

(9) At what time between 8 and 9 o'clock is the minute hand as far beyond the mark V. as the hour hand is beyond the mark VIII. on the face of the clock?

(10) Find a number between 893 and 931 which shall have with each of them the same highest common divisor that they have with each other.

Exercise IX.

(1) A rod 10 in. long is drawn out $\frac{1}{10}$ of its own length; what fraction of its present length must be cut off to reduce it to its original length?

(2) A merchant adds $\frac{1}{10}$ to the cost of his goods; what fraction of the marked price must he deduct to sell off his goods at cost? If the marked price is an advance of 20% on cost, what is the heaviest discount the merchant can allow on this marked price without losing money on the goods?

(3) A storekeeper sells 11 lb. of sugar for \$1, but the cost of sugar advances 10%; how many pounds can he now sell for \$1?

(4) A bicyclist going at 10 mi. per hour expects to arrive at his destination in 44 min., but finding better road he increases his speed to 11 mi. per hour; how many minutes will he gain on the time?

(5) A parcel of gold coins contained 9 more coins than the banker expected from the weight. A close examination showed that 21 of these light coins weighed only as much as 20 true coins; how many coins were there in the parcel?

Hint.—$\frac{1}{20}$ *less* weight would give $\frac{1}{21}$ *more* coins; 9 = $\frac{1}{21}$ of No.

(6) An agent sold wheat at 4% commission on the price received, he is also to receive 2% commission on the price of sugar to be purchased after deducting both commissions, which come to \$63. Find the cost of the sugar, the value of the wheat and the amount of each commission.

Solution.—Price of wheat = cost of sugar + double com. *(A)*

1st com. = 4% wheat = 4% sugar + 4% double com.

2nd com. = 2% sugar

Double com. = 6% sugar + 4% double com. *(B)*

∴ 96% double com. = 6% sugar = 96% of \$63;

∴ value of sugar = \$1,008.

Again, 102% double com. = 6% sugar + 6% double com. (from *B*.)

= 6% wheat (from *A*), ∴ wheat = \$1,071,

Hence, 1st commission = \$42.84; 2nd commission = \$20.16.

ENTRANCE EXAMINATIONS.

July, 1873.

(1) By what number must £4 16*s.* $3\frac{1}{4}d.$ be multiplied to give a product of £89 17*s.* $3\frac{3}{4}d.$?

(2) If I own $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{2}{3}$ of a ship worth \$20,000, and sell $\frac{1}{4}$ of the ship, what will the part I have left be worth?

(3) Prove the rule for multiplication of fractions.

Simplify $\dfrac{1\frac{2}{11}}{1\frac{3}{5}} \div \left(\dfrac{2\frac{7}{11}}{4\frac{4}{10}} - \dfrac{1\frac{3}{4}}{3\frac{1}{4}}\right) + 3\frac{1}{2}.$

(4) If A can do a work in $3\frac{3}{4}$ dy., and B in $4\frac{1}{2}$ dy., in what time will both working together do the work?

(5) If the 2 lb. loaf cost $6\frac{3}{4}$c., when wheat is \$1.10 per bushel, what is the price of wheat when the 2 lb. loaf costs $7\frac{1}{2}$c.?

(6) Simplify $\dfrac{3\frac{1}{2} - \cdot 04}{5 - \cdot 0625} \div \dfrac{\cdot 015 + 2\cdot 1}{\cdot 035}$

(7) Find the expense of fencing a railway (both sides) 73 mi. in length, at the rate of \$5.50 per rod.

(8) If a wheel make 260 revolutions in passing over 1 mi. 520 yd. 2 ft., what is its circumference?

(9) Find cost of 7,225 lb. coal at \$7.25 per ton of 2,000 lb.

(10) Find the sum and difference of $2{,}754\frac{15}{243}$ and $2{,}633\frac{19}{54}$.

January, 1874.

(1) By what must £157 12*s.* $10\frac{1}{2}d.$ be divided to give a quotient of $33\frac{1}{2}$?

(2) How much wheat is necessary to sow a field containing $7\frac{3}{4}$ ac., if $\frac{3}{4}$ of an ounce is sown on every square yard?

(3) How many minutes between 12 o'clock noon May 24th, and half-past nine in the forenoon of September 3rd? and express the answer as a fraction of the year.

(4) Add $(1\frac{1}{9}$ of $\frac{9}{13})$, $(\frac{3}{8}$ of $1\frac{1}{16})$, $\left(\frac{\frac{16}{6}}{\frac{22}{9}}\right)$.

(5) A house and lot cost \$3,600; the value of the lot is $\frac{1}{5}$ that of the house. Find the value of each.

(6) Subtract $2_8\frac{7}{0}\frac{}{0}$ sq. yd. from $\frac{7}{9}$ of $\frac{3}{14}$ of 3 ac.

(7) Prove that multiplying the numerator of a fraction by any number produces the same effect as dividing the denominator by the same number.

(8) Simplify $\cdot 75$ of $1\frac{1}{3} \div 7\cdot 6$ of $\frac{5}{7\,6} - .(1\cdot 875 - 1\frac{5}{8}) \times 2 + \dfrac{4\cdot 875}{4\frac{7}{8}}$

(9) If $\frac{2}{3}$ of $\frac{3}{7}$ of an acre produce 41 bush. of potatoes, how many bushels will an acre produce?

(10) If a man working $9\frac{3}{4}$ hr. per day finishes a piece of work in 6 dy.; in what time would he have finished it if he had worked $8\frac{1}{8}$ hr. per day?

June, 1874.

(1) The *dividend* is one billion two hundred and twenty million two hundred and thirty thousand and ninety-two, the *quotient* six thousand and eighty-four, and the *remainder* forty-eight hundred. Find the divisor.

(2) Reduce 3 ac. 2 ro. 14 sq. pr. 4 sq. ft. 72 sq. in. to square inches; and 170,184 sq. ft. to acres.

(3) 797 tons 19 cwt. 2 qr. 14 lb. is divided among a certain number of people, so that each receives 5 tons 3 cwt. 2 qr. 16 lb. How many people are there?

(4) Show which is the greatest and which the least of the following fractions:—$1\frac{1}{7}$ of $\frac{1}{4}$, $\frac{5}{2\,1}$ of $3\frac{1}{2}$, $\frac{1}{8}$ of $2\frac{5}{8}$.

(5) Reduce to its simplest form—

$$\left\{\frac{2\frac{1}{4} - \frac{2}{3} \text{ of } 1\frac{5}{6}}{\frac{1}{3} \text{ of } 3\frac{1}{5} + \dfrac{6\frac{1}{2}}{18}} + \frac{1}{2\frac{1}{2}}\right\} \div \frac{5\frac{1}{4}}{8\frac{3}{4}}$$

(6) What fraction of £58 5*s.* 6*d.* is $\frac{3}{5}\frac{9}{7}$ of £17 2*s.* 3*d.*?

(7) A man invested $\frac{3}{5}$ of his capital in bank stock, $\frac{3}{4}$ of the remainder in real estate, and had still \$6,000 left. Find his capital.

(8) Find the value of 43 cwt. 2 qr. 21 lb. at £2 16*s.* 8*d.* per cwt. (Qr. = 25 lb.)

(9) Find the difference between

$$\frac{\cdot 26 + \cdot 2 \text{ of } 3\cdot 7}{\cdot 48 - \cdot 014 \text{ of } 20} \text{ and } \frac{4\cdot\dot{3} + 5\cdot\dot{6}}{7\cdot\dot{4} - \cdot\dot{2} \text{ of } 11}$$

(10) A person, after paying out of his income for a year a tax of 4c. in the dollar, has $7,200 left. Find his income for a year.

December, 1874.

(1) The difference between the product of two numbers and 176 is ten millions ten thousand and ten; one of the numbers is twenty-one thousand and twenty-eight; what is the other number?

(2) A cannon ball travels at the rate of 1,500 ft. in a second and a half; how far will it have gone in $\frac{1}{15}$ of a minute?

(3) How many grains are there in 9 oz. 17 dwt. 22 gr., and how many acres, etc., in 167,412,715 sq. in.?

(4) How many yards, etc., of carpet 2 ft. 1 in. wide, will it take to cover a floor that is 19 ft. 7 in. long by 18 ft. 9 in. wide?

(5) After taking out of a purse $\frac{3}{5}$ of its contents, $\frac{3}{8}$ of the remainder was found to be 13*s.* 5½*d.* What sum did it contain at first, and what part of £3 is that sum?

(6) Find the value of

$$\frac{5\frac{5}{8} \div \frac{3}{8}}{1\frac{1}{5} \text{ of } \frac{5}{9} \div 10\frac{1}{3}} \times \frac{2}{5} \text{ of } \frac{1\frac{1}{2} \text{ of } 4\frac{1}{9}}{13\frac{7}{8} \text{ of } 5\frac{1}{3}}.$$

(7) What must be the length of a plot of ground, if the breadth is 15¾ ft., that its area may contain 46 sq. yd.?

(8) A pint contains 34⅔ cub. in.; how many gallons of water will fill a cistern 4 ft. 4 in. long, 2 ft. 8 in. broad, and 1 ft. 1½ in. deep?

(9) Reduce to a simple quantity

$$\frac{2\cdot 8 \text{ of } 2\cdot\dot{2}\dot{7}}{1\cdot 1\dot{3}\dot{6}} + \frac{4\cdot\dot{4} - 2\cdot 8\dot{3}}{1\cdot\dot{3} + 2\cdot\dot{6}\dot{2}\dot{9}} \text{ of } \frac{6\cdot 8 \text{ of } 3}{2\cdot 25}.$$

(10) The chain for measuring land is 66 ft. long, and is divided into 100 links; what is the length of a fence that measures 2,456 links, and how much would it cost at $8.86 per yard?

June, 1875.

(1) Reduce to its lowest terms

$$\left(\frac{2\frac{1}{4} - \frac{2}{3} \text{ of } 1\frac{5}{6}}{\frac{1}{5} \text{ of } 3\frac{1}{3} + \frac{1}{3}\frac{3}{6}} - \frac{1}{2\frac{1}{2}}\right) \div \frac{1}{1\frac{2}{3}}.$$

(2) A merchant bought a number of barrels of flour for \$4,600, and sold them for \$5,200, thereby gaining 75c. per barrel; how many barrels did he buy, and what did it cost him per barrel?

(3) *A* paid \$60 per acre for his farm, which was $\frac{5}{9}$ as much as *B* paid per acre for his farm of 150 ac. Find the entire cost of *B*'s farm.

(4) Find the sum of $\frac{1}{1\frac{1}{2}}$ of £1 13*s.* 0½*d.* + $\frac{1}{8}$ of £1 5*s.* 8½*d.* + $\frac{1}{1\frac{1}{2}}$ of £2 4*s.* 8¾*d.*

(5) A farmer having 17 cwt. 2 qr. 19 lb. of pork, sold 4 cwt. 3 qr. 21 lb. of it, and the remainder he sold in barrels, each containing 2 cwt. 6½ lb.; how many barrels did he sell?

(6) If it takes a man 1 hr. and 40 min. to cut ½ cord of wood, for how many days of 8 hr. each will he be occupied in cutting 186 cords 88 ft.?

(7) A man invests ½ his fortune in land, $\frac{1}{5}$ in bank stocks, $\frac{1}{6}$ in debentures, and loses the remainder, which was \$8,000, in speculation; how much was his fortune?

(8) The *dividend* is fifty-one million eight hundred and forty-six thousand seven hundred and thirty-four, the *quotient* is five hundred and eight thousand three hundred and one, and the *remainder* thirty-two; find the *divisor*.

(9) Find the cost of $49\frac{3}{11}$ yd. of cloth, when $7\frac{5}{8}$ yd. cost £7 18*s.* 4*d.*

(10) A man paid \$2,896,875 for land, and sold 56·25 ac. at \$31 per acre; the remainder then stood him at \$20.05 per acre; how many acres did he buy?

December, 1875.

(1) Find the amount of the following account:—Mr. Markham bought of Mr. Jones, Dec. 8, 1875, 12 yd. Scotch Tweed @ \$2.85, 16 yd. of Silk @ \$2.12½, 50 yd. Ticking @ 14½c., 42 yd. Shirting @ 16½c., 12½ yd. Flannel @ 50c., 20¼ yd. Scotch Plaid @ 60c.

(2) I bought from *A* 97 ac. 2 rd. and 12 sq. rods of land; from *B*, four times as much, less 7 ac. and 1 rd.; and from *C*, ½ as much as from *A* and *B* together. I then sold 120 ac. 1 rd. and 29 sq. rods. How much had I left?

(3) Reduce to its simplest form

$$\left(\frac{13\frac{1}{3}}{28} + \frac{\frac{1}{4}}{2\frac{5}{8}} - \frac{15}{54} \text{ of } \frac{\frac{1}{2}}{\frac{7}{8}}\right) + 5\frac{1}{4}.$$

(4) State the rule for division of Vulgar Fractions, and show by means of an example the reason for it.

(5) A person bought a certain number of barrels of flour for \$2,200; he reserved 20 barrels for use and sold $\frac{4}{5}$ of the remainder for \$1,976, which was \$304 more than cost. Find the number of barrels he bought.

(6) A sum of money is divided among 4 persons. The first receives $\frac{1}{3}$, the second $\frac{1}{4}$, the third $\frac{1}{5}$, and the fourth the remainder. It is found that the first received \$700 more than the fourth. Find the sum received by each.

(7) Add together $\frac{3}{5}$ of £3 7*s.* 6*d.* and $\frac{2}{3}$ of $\frac{1}{4}$ of $4\frac{1}{2}$ guineas, and reduce the result to the fraction of £1 10*s.*

(8) If the annual rent of 46 ac. 3 rd. 14 pr. of land be \$370.70, how much will be the rent of 70 ac. and 20 pr.?

(9) If the price of 1·875 lb. of tea is 1·3749 shillings, how much can be bought for £15 8*s.*?

(10) A hall is 45 ft. long and $11\frac{1}{4}$ ft. wide; what will it cost to carpet it (*a*) with carpet 27 in. wide and \$1.75 per yard; (*b*) with carpet 45 in. wide and \$1.25 per yard?

June, 1876.

(1) Bought $19\frac{1}{2}$ yd. Irish linen at 5*s.* 4*d.*, $16\frac{3}{4}$ yd. calico at 1*s.* 8*d.*, and $16\frac{1}{2}$ yd. of silk at 8*s.* 4*d.*; find the amount of the bill in dollars and cents.

(2) Add together ($\frac{3}{4}$ of $\frac{5}{6}$ of £2 5*s.*), $\frac{2}{7}$ of 3 guineas, and $\dot{2}\dot{7}$ of £1 18*s.* 6*d.* and reduce the result to the decimal of £25.

(3) If a pipe discharge 2 hhd. 23 gal. 2 qt. 1 pt. of water in one hour, in how many hours will it discharge 11 hhd. 25 gal. $1\frac{3}{5}$ pt., the water flowing with the same velocity?

(4) Add together, $\dfrac{16}{\frac{7}{15} \text{ of } 2\frac{8}{11} \times \frac{11}{35}}$, $\dfrac{1\frac{2}{7}}{1\frac{2}{3} \text{ of } 3\frac{9}{10}} \times \dfrac{1}{1\frac{5}{11}}$,

and divide the result by $\dfrac{3\frac{2}{3} \text{ of } 5\frac{1}{4} \text{ of } 7\frac{1}{2}}{63} - \dfrac{1}{3\frac{1}{2}} - \dfrac{\frac{4}{17} \times \frac{3}{14}}{\frac{1}{8}}$.

(5) A man's annual income is \$2,400; find how much he may spend per day so that after paying a tax of 2c. $7\frac{1}{2}$ mills on every dollar of income he may save \$582 per year (365 dy.)

(6) A room is 36 ft. long and 24 ft. wide; find the difference in the expense of carpeting it with carpet a yard wide at \$1.40 per yard, and with carpet 27 in. wide at \$1.15 per yard.

(7) If 162 gal. of water will fill a cistern 4 ft. 4 in. long, 2 ft. 8 in. broad, and 2 ft. 3 in. deep, how many cubic inches are contained in a pint?

(8) Three men can mow a field in 6 dy.; they mow together for 2 dy., and then 1 of them ceases work, and the other 2 finish the field in 7 dy.; find how long the man who ceased work at the end of the second day would have taken to mow the whole field by himself.

(9) A man sold two city lots for \$600 each; on the one he gained $\frac{1}{4}$ of the price it cost him, and on the other he lost $\frac{1}{4}$ of the price it cost him; find his entire loss on the sale of the two lots.

(10) A drover bought a number of cattle for \$4,375, and sold a certain number of them for \$43 per head for the total sum of \$3,655, gaining \$680; for how much per head must he sell the remainder so as to gain \$400 more?

December, 1876.

(1) How many square inches are there in 3 ac. 2 ro. 27 pr. 27 sq. yd. 7 sq. ft. 23 sq. in.; and how many tons, cwt., etc., in 37,496 lb. and 4,763 oz.?

(2) A persons owns $\frac{3}{8}$ of a ship, and sells $\frac{2}{3}$ of his share for £1,260. What is the value of the ship?

(3) The difference between the product of two numbers and 2,431 is three hundred millions three hundred and three thousand and three. One of the numbers is twenty thousand three hundred and six. Find the other.

(4) Show which is the least and which the greatest of the following fractions:—$\frac{1}{9}$ of $9\frac{1}{9}$, $\frac{8}{9}\frac{2}{0}$ of 9, and $\frac{2}{8}\frac{0}{2}$ of 8·2.

(5) If telegraph posts are placed 80 yd. apart, and a train passes one every four seconds; how many miles an hour is it running?

(6) A regiment marching $3\frac{1}{2}$ mi. an hour takes 110 steps in a minute. What is the length of the step?

(7) How many yards of carpet 15 in. wide will cover the floor of a room $22\frac{1}{2}$ ft. by 19 ft.?

(8) Simplify $83 - 1\frac{7}{9}$ of $2\frac{5}{20}$ of $1\frac{1}{5} + 2\frac{1}{2} \div \frac{3}{14} - 7$.

(9) Find the sum of $6\cdot2\dot{7}$, $18\cdot6\dot{5}\dot{1}$, and $12\cdot3\dot{4}\dot{5}$, and the difference between $\cdot3402\dot{7}$ and $\cdot2\dot{7}$.

(10) If a room be 12 ft. square, what must its height be in order that the area of the walls may amount to 60 sq. yd.?

July, 1877.

(1) What is the least number that must be added to five millions to make the sum exactly divisible by seven thousand and nineteen?

(2) Simplify $\frac{20}{21} - \left(\frac{48\frac{1}{2} + 7\frac{2}{3} - 16\frac{3}{4}}{16\frac{1}{2} \times 14\frac{1}{3} \times 12\frac{1}{4}} \div \frac{5\frac{2}{7}}{7\frac{2}{5}}\right)$

(3) Simplify $\frac{£14\ 12s.\ 11d.}{10\frac{1}{5} - 3\frac{5}{6}} \times \frac{£10\ 10s.\ 10d.}{10s.\ 9\frac{1}{2}d.}$

(4) A man bought a quantity of hay at \$15 for 20 cwt. He sold it at 85c. per cwt., gaining \$22.25. How many hundredweight did he buy?

(5) $3\frac{1}{8}$ yd. of cloth cost \$12.50; what will $23\frac{7}{16}$ yd. cost?

(6) A person having an annual income of \$1,400 spends a sum equal to \$625.50 more than he saves. Find his daily expenditure (year = 365 dy.)

(7) A lady had in her purse just money enough to buy a certain quantity of silk; but she spent $\frac{3}{10}$ of the money in flannel, $\frac{3}{5}$ of the remainder in calico, and had then only enough money left to buy $10\frac{1}{2}$ yd. of silk. How many yards of silk could she have bought at first?

(8) A room 15 ft. wide and 18 ft. long is covered with matting at a cost of \$25; what would be the expense of covering, with the same quality of matting, a room a yard longer and a yard wider?

(9) The average of four quantities is $18\frac{3}{9}\frac{5}{7}$; the first is $26\cdot20\dot{7}$, the second $3\cdot59\dot{2}$, and the third is $38\cdot06\dot{}$. Find the fourth.

(10) A bankrupt owes to *A* \$1,039.84, and to *B* \$612.80; if *A* receives $\$357.44\frac{1}{2}$, what will *B* receive?

December, 1877.

(1) How often is 6 yd. 2 ft. contained in 25 furlongs?

(2) If I buy 3 bush., paying 5c. for every 3 qt., and sell it at a profit of 10c. per gallon, find the selling price of the whole.

(3) Simplify $\dfrac{2\frac{1}{2} + \frac{5}{8} \text{ of } 12 - \frac{5}{6}}{3\frac{1}{3} \times \cdot 01 + \frac{9}{10}} \times \dfrac{11}{3\frac{2}{3}} \times \dfrac{18\frac{1}{12} + 5\frac{8}{15} - 22\frac{23}{30}}{\frac{1}{1\frac{1}{2\frac{1}{7}}} \div (2\frac{7}{10} - \frac{5}{8} + 4)}$

(4) Reduce 2 hr. 20 min. to the decimal of $3\frac{1}{3}$ wk.

(5) A sum of money was divided among *A*, *B* and *C*. *A* received $\frac{2}{5}$ of the sum; *B* \$20 less than $\frac{3}{4}$ of what was left; and the remainder, which was $\frac{3}{4}$ of *A*'s share, was given to *C*. Find the sum divided.

(6) Trees are planted 12 ft. apart around the sides of a rectangular field 40 rods long and containing 2 ac. Find the number of trees.

(7) I buy a farm containing 80 ac. and sell $\frac{3}{4}$ of it for $\frac{3}{5}$ the cost of the farm; I then sell the remainder at \$60 per acre, and neither gain nor lose by the whole transaction. Find the cost of the farm.

(8) Find the amount of the following bill of goods:—

$18\frac{3}{4}$ cords of wood @ \$3.50 per cord.
16 yd. of cloth @ \$1.12½ per yard.
12 bush. 25 lb. of wheat @ \$1.20 per bushel.
1,400 ft. of lumber @ \$12.50 per thousand.
65 tons, 12 cwt. of coal @ 30c. per cwt.

July, 1878.

(1) Define prime number, multiple of a number, highest common factor of two or more numbers. Find the prime factors of 1,260.

(2) The quotient is equal to six times the divisor; the divisor is equal to six times the remainder, and the three together, plus 45, amount to 561. Find the dividend.

(3) I sell $12\frac{1}{2}$ tons of coal for \$80, which is $\frac{1}{17}$ more than the cost. Find the gain per cwt.

(4) $\cdot 001 \times \cdot 001 \div \cdot 0001$.

(5) A cistern is $\frac{2}{3}$ full; one pipe runs out and two run in. The first pipe can empty it in 8 hr., the second can fill it in 12 hr., and the third can fill it in 16 hr. There is also a leak half as large as the second pipe, in how many hours will the cistern be half full?

(6) Ten men can do a piece of work in 12 dy. After they have worked 4 dy. 3 boys join them in the work, by which means the whole is done in 10 dy. What part of the work is done by 1 boy in 1 dy.?

(7) I buy a number of boxes of oranges for $600, of which 12 boxes are unsaleable. I sell $\frac{3}{5}$ of the remainder for $400, and gain on them $40. How many boxes did I buy?

(8) Find the total cost of the following:—Cutting a pile of wood 80 ft. long, 6 ft. high, 4 ft. wide, at 60c. per cord; digging a cellar 44 ft. long, 30 ft. wide, 8 ft. deep, at 18c. per cubic yard; plastering a room 24 ft. long, 16 ft. wide, 10 ft. high, at 15c. per square yard; sawing 6,800 shingles at 40c. per 1,000.

December, 1878.

(1) (*a*) Define abstract number, composite number, common multiple of two or more numbers; and explain by an example the use of the numerator of a fraction.

(*b*) Express in figures four hundred billions, four millions, forty thousand and four units.

(2) A man has 5 tons 6 cwt. of flour; after selling 25 barrels of 196 lb. each, how many sacks holding 150 lb. can be filled with the remainder?

(3) How many rails in a straight fence 40 rods long, 5 rails high, each rail being 10 ft. long?

(4) If it cost $57.60 to carpet a room 20 ft. long with carpet $2\frac{1}{2}$ ft. wide at $1.20 per yard, find the width of the room.

(5) Find the value of $\dfrac{5\frac{1}{2} \text{ of } \frac{2}{9} \text{ of } 2\frac{1}{7} - 1 \div (\frac{1}{5} + \frac{1}{2})}{1 - \frac{3}{14} \text{ of } \left(\frac{1}{2} + \frac{1}{2} \text{ of } \frac{2\frac{1}{0}}{\frac{1}{7} \text{ of } 1\frac{1}{2\frac{1}{0}}}\right)}$

(6) A pint contains $34\frac{2}{3}$ cubic inches; how many gallons of water will fill a cistern 4 ft. 4 in. long, 2 ft. 8 in. wide, and 6 ft. $1\frac{1}{2}$ in. deep?

(7) If 12 men earn $120 in 12 dy. by working 10 hr. per day, in how many days will 15 men earn $150 by working 8 hr. per day?

(8) A and B have together 210 ac. of land, and $\frac{3}{4}$ of A's share is equal to $\frac{5}{7}$ of B's share. B paid \$1,470 for his land; for how much must he sell it to gain \$20 per acre?

July, 1879.

(1) Define abstract number, factors of a number, least common multiple of two or more numbers, common denominator.

(2) Simplify $5 - \dfrac{6}{3 \div \left(2\frac{1}{4} + \dfrac{2}{3 - 2\frac{2}{3}}\right)}$

(3) From one hundred and one thousandths subtract one hundred thousand nine hundred and ninety-nine millionths, and multiply the result by one hundred and one tenths of thousandths.

(4) If the water in a cistern 8 ft. long, 4 ft. wide, and 12 ft. deep, weighs 12 tons, find the weight in ounces of one cubic foot of water.

(5) Reduce $\dfrac{3\frac{1}{7}}{5\frac{4}{8} \text{ of } 3\frac{3}{7}}$ of $\dfrac{16\frac{5}{12} - 5\frac{1}{12}}{5\frac{1}{4} - 3\frac{3}{4}(2\frac{1}{2} \times \frac{3}{10})}$ of ·005 of a ton to the fraction of a cwt.

(6) Find the cost of wheat, at 80c. per bushel, which will be required to sow a field 60 rods long and 40 rods wide, if $\frac{3}{4}$ of an ounce be sown on every square yard.

(7) How many bricks, each covering 36 sq. in., will be required to pave a walk 6 ft. wide around the outside of a rectangular field 10 rods long, which contains $\frac{1}{2}$ an acre?

(8) A train 40 rods long overtakes a man walking 3 mi. per hour, and passes him in 12 sec.; how many miles per hour is the train running?

December, 1879.

(1) A man has 703 ac. 3 ro. 22 sq. rods $14\frac{1}{4}$ sq. yd.; after selling 19 ac. 1 ro. 30 sq. rods $2\frac{1}{4}$ sq. yd., among how many persons can he divide the remainder so that each person may receive 45 ac. 2 ro. 20 sq. rods 25 sq. yd.?

(2) Find the price of digging a cellar 41 ft. 3 in. long, 24 ft. wide, and 6 ft. deep, at 20c. per cubic yard?

(3) The fore wheel of a waggon is $10\frac{1}{2}$ ft. in circumference, and turns 440 times more than the hind wheel, which is $11\frac{3}{8}$ ft. in circumference; find the distance travelled over in feet.

(4) $\dfrac{3\frac{1}{3} - 1\frac{1}{6} \text{ of } \frac{9}{10} + 8}{\frac{11}{12}(8\frac{5}{12} + 3\frac{5}{8} - \frac{7}{12} + 3\frac{3}{3})} \div \dfrac{\cdot 05 - \cdot 005}{\cdot 25 \div \cdot 5}$.

(5) Find the total cost of the following:—

2,745 lb. of wheat at \$1.20 per bushel.
867 " oats " 35c. "
1,936 " barley " 60c. "
1,650 " hay " \$8 per ton.
2,675 ft. of lumber " \$10 per 1,000 ft.

(6) If, when wheat sells at 90c. per bushel, a 4 lb. loaf of bread sells at 10c., what should be the price of a 3 lb. loaf when wheat has advanced 45c. in price?

(7) At what price must I mark cloth which cost me \$2.40 per yard, so that after throwing off $\frac{1}{5}$ of the marked price I may sell it at $\frac{1}{5}$ more than the cost price?

June, 1880.

(1) Multiply one hundred and seventy-four millions five hundred and fifty thousand six hundred and thirteen by six hundred thousand four hundred and seventeen. Explain why each partial product is removed one place to the left.

(2) Define Measure, Common Measure, and Greatest Common Measure.

Find the G. C. M. of 153,517 and 7,389,501,522.

(3) Shew that $\frac{3}{8} = \frac{8}{12}$.

Simplify $\dfrac{4\frac{1}{13} \text{ of } \frac{8}{15} \text{ of } 7\frac{3}{7}}{12\frac{1}{35} - 2\frac{3}{7}} + \dfrac{2\frac{1}{3} + 1\frac{3}{4}\frac{5}{8}}{9\frac{2}{7} - 3\frac{3}{1}\frac{9}{2}} - \dfrac{12354}{12355}$.

(4) A brick wall is to be built 90 ft. long, 17 ft. high, and 4 ft. thick; each brick is 9 in. long, $4\frac{1}{2}$ in. wide, and $2\frac{1}{2}$ in. thick. How many bricks will be required?

(5) A merchant received a case of goods invoiced as follows:—
12 pieces of silk, each 48 yd., at 5*s.* 3*d.* per yard.
15 pieces of cotton, each 60 yd., at $6\frac{1}{4}d.$ per yard.
20 pieces of cotton, each 56 yd., at $4\frac{3}{4}d.$ per yard.
14 pieces of Irish linen, each 40 yd., at 1*s.* $3\frac{1}{2}d.$ per yard.
Supposing the shilling to be worth $24\frac{1}{3}$c., find the amount of the above bill of goods.

(6) Divide 76·391955 by nine hundred and twenty thousand three hundred and eighty-five *ten-billionths.*

(7) D. D. Wilson, of Seaforth, exported last year 8,360 barrels of eggs, each containing the same number. He received an average price of 14·85c. per dozen. Allowing the cost (including packing, etc.), to have been 13·5c. per dozen, and the entire profit to have been $7,900.20, find the number of eggs packed in each barrel.

(8) The dimensions of the *Globe* newspaper are 50 in. by 32 in., and the daily issue is about 24,000 copies, how many miles of Yonge street, which is about 70 ft. wide, might be covered with ten weeks' issue?

(9) A flagstaff 120 ft. high was broken off by the wind, and it was found that ·76 of the longer part was $\frac{2}{5}$ of $9\frac{1}{2}$ times the shorter part. Find the length of each part.

(10) *A* and *B* together can do a piece of work in $\frac{3}{4}$ of a day, *B* and *C* in $\frac{9}{10}$ of a day, and *C* and *A* in $1\frac{3}{5}$ of a day. In what time could all working together do the work?

December, 1880.

(1) Define Number, Numeration, Notation, Addend, Minuend.

(2) Find the G. C. M. of sixty-eight million five hundred and ninety thousand one hundred and forty-two, and eighty-five million forty-four thousand and fifty-nine.

(3) For a voyage of 17 wk. a ship takes provisions to the amount of 48 tons 4 cwt. 2 qr. 20 lb. 9 oz. Supposing that there are 73 men aboard, how much may be allowed each man per day?

(4) Find the amount of the following bill:—$14\frac{3}{4}$ lb. beef @ 10c.; $12\frac{1}{2}$ lb. pork @ $9\frac{1}{2}$c.; 3 turkeys, weighing in all $35\frac{1}{2}$ lb., @ $12\frac{1}{2}$c. per lb.; 12 lb. 10 oz. lard @ 15c. per lb.; 5 geese, weighing in all 45 lb. 12 oz., @ 10c. per lb.

(5) Simplify $\dfrac{5\frac{5}{9} \text{ of } \frac{3}{5} + 3\cdot\dot{3} \text{ of } 2 - 1\frac{1}{2}}{\frac{1}{17} \text{ of } (2\cdot0\dot{1}\dot{5} \div \cdot5)}$ of $\dfrac{£19\ 16s.\ 7\frac{3}{4}d.}{£20\ 16s.\ 8\frac{3}{4}d.}$

(6) What is the weight of a block of stone 12 ft. 6 in. long, 6 ft. 6 in. broad, and 4 ft. $1\frac{1}{2}$ in. thick, when a block of the same kind of stone 2 ft. 6 in. long, 3 ft. 9 in. broad, and 1 ft. 3 in. thick, weighs 1,875 lb.?

(7) A man, after paying an income tax of $15\frac{1}{2}$ mills on the dollar, and spending $\$3.37\frac{1}{2}$ per day, is able to save $\$1,230.87\frac{1}{2}$ per year (365 dy.) Find his gross income.

July, 1881.

(1) (*a*) Define Subtrahend, Multiplicand, Quotient. Explain the statement: "The multiplier must always be regarded as an abstract number."

(*b*) Divide 2,000,000,018,760,681 by sixty-three million two hundred and forty-five thousand five hundred and fifty-three.

(2) Define Prime Number, Prime Factors. How do you resolve a number into its prime factors?

Resolve 132,288 and 107,328 into their prime factors, and find their least common multiple.

(3) How many minutes are there in $\frac{1}{7}\frac{9}{3}$ of a year (365 dy.) + $\frac{3}{5}\frac{}{6}$ of a week + $\frac{}{2}\frac{5}{4}$ of $3\frac{1}{2}$ dy.?

(4) $\dfrac{\frac{17}{10} + \frac{7}{11}}{\frac{17}{10} - \frac{7}{11}} - \dfrac{9 + \frac{1}{2}\frac{4}{7}}{2 + 2\frac{1}{3}} + 1761\frac{5}{4}\frac{}{8} - 1650\frac{1}{4}\frac{3}{3}\frac{1}{2}$.

(5) A grain dealer buys 5,225 bush. of wheat at \$1.05 per bushel, and paid \$125 for insurance, storage, etc.; he sold ·4 of the quantity at 97c. per bushel. At what price per bushel must he sell the remainder in order to gain \$522.50 on the whole?

(6) Find the quotient of ·9840018 ÷ ·00159982 to seven decimal places; and reduce ·7002457̇ to a vulgar fraction.

(7) Water in freezing expands about $\frac{1}{9}$ in volume. How many cubic feet of water are there in an iceberg 445 ft. long, 100 ft. broad, and 175 ft. high?

December, 1881.

(1) Divide three hundred and fourteen and *one hundred and fifty-nine thousandths* by eight thousand nine hundred and thirty-seven *ten-billionths.*

(2) Divide the difference of $13\frac{1}{3} \div \{ (2\frac{6}{7} - 2\frac{8}{11}) \times 1\frac{4}{7} \}$ and $\{ 13\frac{1}{3} \div (2\frac{6}{7} - 2\frac{8}{11}) \} \times 1\frac{4}{7}$ by $13\frac{1}{3} \div 2\frac{6}{7} - 2\frac{8}{11} \times 1\frac{4}{7}$.

(3) Find the amount of the following bill in dollars and cents, the shilling being worth 24$\frac{1}{3}$c.:—115 yd. Brussels carpet @ 5*s.* 10*d.*, 95 yd. Dutch stair @ 2*s.* 7*d.*, 84 yd. Kidderminster @ 3*s.* 7*d.*, 72 yd. drugget @ 2*s.* 8*d.*, 10 doz. stair rods @ 5*s.* 6*d.*

(4) Lead weighs 11·4 times as much as water, and platinum weighs 21 times as much as water. What weight of platinum will be equal in bulk to 56 lb. lead?

(5) Find the difference in cost between 200 ft. of chain cable, 76 lb. to the foot, and 600 ft. of wire rope, 18 lb. to the foot, the chain costing 15*s.* 6*d.*, and the rope costing 23*s.* 6*d.* per cwt.

(6) By selling tweed at \$2.60 per yard it was found that $\frac{5}{8}$ of the cost was gained; what selling price would have gained ·7 of the cost?

(7) A plate of copper 5 ft. 6 in. long, 3 ft. wide, and $\frac{3}{4}$ in. thick, is rolled into a sheet 4 ft. 6 in. wide, and 6 ft. long. Find its thickness.

(8) How many bricks, 9 in. long, $4\frac{1}{2}$ in. wide, and 4 in. thick, will be required for a wall 60 ft. long, 17 ft. high, and 4 ft. thick, allowing that the mortar increases the bulk of each brick $\frac{1}{16}$?

(9) A grocer gained 20% by selling 10 lb. sugar for \$1. Afterwards he increased his price, giving only 9 lb. for \$1. How much per cent. did he make at the increased price?

June, 1882.

(1) Define Greatest Common Measure. State the principle on which the rule for finding the G. C. M. of two numbers depends.

Find the G. C. M. of 68,590,142, and 85,054,059.

(2) A dealer bought 8 carloads of lumber, each containing 9,870 ft., at \$13.50 per M. He retailed it at \$1.43 per 100 ft. Find his gain on the whole lot.

(3) Show that $\frac{3}{4} = \frac{6}{8}$, and that $\frac{3}{5} \div \frac{4}{5} = 1\frac{1}{2}$.

Simplify the following:—

$$\frac{26\frac{3}{7} - 1\frac{1}{2}\frac{3}{7}}{\frac{4}{9} + 1\frac{1}{3} - \frac{3}{5} \text{ of } \frac{17\frac{1}{2}}{12} \text{ of } \frac{5}{9} \div \frac{3}{2}\frac{5}{4}} \text{ of } \frac{5\frac{1}{2}}{521}$$

(4) Prove that $2{\cdot}3 \times {\cdot}04 = {\cdot}092$.

Add together 154·2125, ·5421, ·0001235, 741·206, ·03, and 4567·0004.

Reduce 75·0125 cwt. to ounces.

(5) A steamer makes a nautical mile (6,072 ft.) in 3 min. 50 sec. Find her rate per hour in statute (common) miles.

(6) There is a solid pile of bricks which is 36 ft. long, 16 ft. 6 in. wide, and 14 ft. 6 in. high, and contains 122,496 bricks of uniform size; each brick is 9 in. long and $4\frac{1}{2}$ in. wide; find its thickness.

(7) A London merchant transmits £250 10*s.* through Paris to New York; if £1 = 24 francs, and 6 francs = \$1.14 American currency, what sum in American currency will the merchant realize?

(8) In a map of a country the scale is $\frac{1}{10}$ of an inch to a mile (*i.e.* $\frac{1}{10}$ of an inch represents a mile), and a township is represented on this map by a square whose side is half an inch. How many acres in a township?

(9) If 4 men or 6 boys can do a work in 8 dy., how long will it take 8 men and 4 boys to do such a piece of work?

(10) *A* and *B* were candidates for election in a constituency of 2,700 voters. The votes polled by *A* were, to those polled by *B*, as 23 to 25, and *B* was elected by a majority of 100. How many persons did not vote?

December, 1882.

(1) From 935 take 846, explaining clearly the reason for each step.

The difference between 82,610 and the product of two numbers is 70,300,000. One of the numbers is 9,402; find the other.

(2) Find the amount of the following bill:—36 lb. 8 oz. beef @ 16c., 16 lb. 10 oz. mutton @ 14c., 7 lb. 12 oz. pork chops @ 12c., 15 lb. 6 oz. turkey @ 18c., 4 lb. 10 oz. suet @ 16c.

(3) Find the L. C. M. of 11, 14, 28, 22, 7, 56, 42, 81; and the G. C. M. of 40,545, 124,083.

(4) Prove that $\frac{3}{4}$ of $1 = \frac{1}{4}$ of 3.

Simplify $\dfrac{\frac{5}{14} - \frac{3}{7} \text{ of } \frac{1}{2}}{\frac{5}{16} + \frac{7}{12} \text{ of } 3\frac{1}{4} - (\frac{7}{8} \text{ of } \frac{37}{21} - \frac{1}{3})} \div \dfrac{\frac{1}{3} \text{ of } \frac{1}{2} + \frac{3}{2} \text{ of } 5}{9\frac{1}{3} - 1\frac{2}{3}}$

(5) Prove that $1{\cdot}025 \div {\cdot}05 = 20{\cdot}5$.

Find the cost of ·0625 of 112 lb. sugar, when 1 lb. costs ·0703125 of 16*s*.

(6) Reduce 45,740,108 sq. in. to acres.

(7) The bottom of a cistern is 7 ft. 6 in. by 3 ft. 2 in. How deep must it be to contain 3,750 lb. of water, a cubic foot of water weighing 1,000 oz.?

(8) *A* runs a mile race with *B* and loses; had his speed been a third greater he would have won by 22 yd. Find the ratio of *A*'s speed to *B*'s.

(9) *A* does $\frac{2}{3}$ of a piece of work in 6 hr.; *B* does $\frac{3}{4}$ of what remains in 2 hr.; and *C* finishes the remainder of the work in 30 min. In what time would all working together do the work?

(10) By selling tea at 60c. per pound a grocer loses 20%; what should he sell it at to gain 20%?

June, 1883.

(1) What is the object of Division? Write down the relation connecting the Divisor, Dividend, Quotient, and Remainder.

Divide 108,419,716,001 by 18,748,005.

(2) Find, by "casting out nines," whether the following is correct:—$349,751 \times 28,637 = 10,015,819,397$.

Find the weight of 500,000 bricks at 4 lb. 2 oz. each, and the cost—in dollars and cents—at 27*s.* 6*d.* each, allowing 4*s.* 2*d.* to make a dollar.

(3) A merchant received from England the following invoice in sterling:—

375 tons iron plate @ £8 15*s.* 6*d.*
107½ tons bar iron @ £11 14*s.*
10 tons bulb iron @ £10 10*s.*
17 tons T iron @ £15 10*s.*
48 tons steel @ £18 7*s.* 6*d.*
15 tons rivets @ £11 1*s.*

Find the amount of this invoice in Canadian currency, allowing the shilling sterling to be equal to 24⅓c.

(4) At $1.75 per rod, what will it cost to fence a piece of land 63·5 rods long and 27·75 rods wide?

(5) Simplify

$$1 - \frac{1}{6} + \frac{1}{24} - \frac{61}{5040} + \frac{277}{72576}; \text{ and } \frac{4\frac{7}{16} + 5\cdot\dot{8}\dot{1} - 2\cdot5}{4\frac{7}{16} \text{ of } 32 \text{ of } \cdot\dot{4}\dot{5}}$$

(6) Gunpowder is composed of nitre, charcoal and sulphur, in the proportion of 15, 3, and 2. A certain quantity of gunpowder is known to contain 20 cwt. of charcoal; find its weight, and also the weight of nitre, and of sulphur it contains.

(7) Bought 360 gal. of wine at $2.60 per gallon; paid for carriage $17.20, and for duties $86.50. If $\frac{3}{20}$ of it be lost by leakage, at what price must the remainder be sold to gain $50 on the whole transaction?

(8) Find the interest on a note for $257.81, dated Jan. 3, 1883, and paid April 6, 1883, at 8% per annum.

(9) The length of a second's pendulum is 39·37079 in.; if 64 French metres are equal to 70 yd., by what decimal of an inch will the length of a second's pendulum differ from one metre?

(10) At what time between 4 and 5 o'clock are the hands of a clock (*a*) coincident, (*b*) at right angles?

December, 1883.

(1) Multiply the sum of 59,404 and 47,675 by their difference, and divide the product by $7 \times 13 \times 19$.

(2) Bought oranges at the rate of 10c. per dozen, and sold them at the rate of 5 oranges for 11c. How much did I gain on 11 boxes, each containing 20 doz.?

(3) A man bought a rectangular field 40 rods long by 25 rods wide, paying therefor at the rate of $300 per acre, and then had it fenced at the rate of $1.50 per rod. Prove that the land cost him exactly ten times as much as the fence.

(4) Divide $1,200 among A, B, and C, so that A may have $70 more than B and twice as much as C.

(5) Divide the sum of $\frac{2}{5}$ of $8\frac{1}{3}$ and $2\frac{1}{7}$ of $5\frac{5}{8}$ by the difference between $\frac{3}{7}$ of $3\frac{1}{2}$ and $\frac{1}{2}$ of $\frac{1}{3}$ of $2\frac{2}{3}$.

(6) Add together 1·302, 3·2589, and 40·93. Multiply the sum by ·00297, and the product by 90·09. (Decimals, not vulgar fractions, to be used in doing the work, otherwise no marks to be allowed.)

(7) A farmer sold a load of hay at $16.25 per ton; the whole weight of the waggon and hay was 2,875 lb.; the waggon alone was found to weigh 1,083 lb. How much did the farmer receive for his hay?

(8) A can run a mile in 5 min., B can run it in 6 min. How many yards start should A allow B in order to make their chances equal?

(9) Three men can dig a certain drain in 8 dy. They work at it for 5 dy., when one of them falls ill, and the other two finish the work in 5 dy. more. How much of the work did the first man do before he fell ill?

(10) Find the interest on $275.80 for 91 dy. at 7% per annum.

June, 1884.

(1) The quotient is 12,434, the remainder 2,763, and the dividend eighty-seven millions nine hundred and eleven thousand one hundred and forty-three. Find the divisor.

(2) Find the L. C. M. of 11, 7, 21, 28, 22, 27, 81, 243, 216; and the G. C. M. of 94,605 and 96,509.

(3) A sidereal day is 23 hr. 56 min., and the mean solar day is 24 hr. Reduce the difference between the two to the decimal of a sidereal day.

(4) Simplify (*a*) $\frac{(3\frac{2}{5} - \frac{2}{11}) \text{ of } 6\frac{5}{12}}{1\frac{7}{10} - \frac{1}{11} \text{ of } 12\frac{5}{6}} \div (6\frac{1}{5} - 1\frac{1}{7})$.

(*b*) $\frac{\frac{3}{16} \text{ of a guinea} - \frac{2}{15} \text{ of a £}}{8s.\ 10\frac{3}{4}d.}$.

(5) A grain dealer bought 64 bags of oats, weighing (including bags) 3,616 lb. The bags averaged 1 lb. 12 oz. each. The dealer paid 34c. per bushel for the oats, and sold them at 42½c. per bushel. How much was his gain?

(6) A plate of metal ½ in. thick was burnished on one side for 11*s.* 6½*d.*, at 2¼*d.* per square inch. Find the weight of the plate, supposing a cubic foot of the metal to weigh 62½ lb.

(7) *A*, *B*, and *C* do a work in 12 hr.; *A* and *B* can do it in 16 hr., and *A* and *C* in 18 hr. In what time can each do it separately?

(8) An army, in its first engagement, lost 1 in 10 in killed and wounded, and in its second engagement 3 in 25 of the remainder; there were then 3,960 men left. How many men went into the first engagement?

(9) Find the duty on 8 hogsheads of sugar, each weighing 1,200 lb. gross, at 1⅜c. per pound, 16% being allowed for tare.

(10) (*a*) Find the interest on $225.40 for 16 mo. at 8 % per annum.

(*b*) The amount of a certain principal was $307.20 for 3½ yr., and $312 for 3¾ yr. Find the principal and the rate.

December, 1884.

(1) Of what number is 8,967 both divisor and quotient?

(2) Find the greatest number that will divide 11,067 and 35,602, leaving as remainder respectively 17 and 21.

(3) Find the amount of the following bill:—12½ yd. cassimere @ $2.75 per yard, 18⅓ yd. silk @ $1.17, 23¾ yd. flannel @ 37½c., 112 yd. print @ 9⅛c., 55 yd. shirting @ 17½c., 37½ yd. tweed @ $1.12.

(4) Simplify (*a*) $5\frac{1}{2} + 2\frac{1}{3} \div 11\frac{3}{4} \times 7\frac{1}{2} + \frac{\$18.64}{\$1.16\frac{1}{2}}$.

(*b*) $(\frac{4}{5} \times \frac{9}{11} \times 0{\cdot}02 \times 0{\cdot}456) \div \frac{1}{17}$ of $\frac{2}{3}$.

(5) The cost of carpeting a room 15 ft. long, with carpet 27 in. wide, costing 90c. per yard, is $22.50. What is the width of the room?

(6) A boy can do a piece of work in $4\frac{2}{3}$ dy., and a man can do the same in $\frac{3}{7}$ of the time. How many days will both working together require to do five times the amount of work?

(7) How much water must be added to 92 gals. of brandy, worth $4.60 per gallon, in order that the mixture may be worth only $3.60 per gallon?

(8) Find the simple interest on $275.60 from 18th July, 1883, till 13th Sept., 1884, at 6% per annum.

(9) At what time are the hands of a clock exactly 2 min. spaces apart between 4 and 5 o'clock?

June, 1885.

(1) Express in words :—17089653·005904, $705·637, and MDCCCLXXXV.

(2) Simplify $\frac{7}{47}(3\frac{1}{2} + 9\frac{1}{14}) \div \frac{1}{13}$ of $\frac{£15\ 10s.\ 2d.}{16s.\ 2d.}$.

(3) Find the value of $17\cdot6\dot{5}\dot{4} + 4\cdot\dot{8}3\dot{5} + 6\cdot40\dot{8}$.

(4) Make out a bill of the following goods :—23 yd. cotton @ 11c., 13 yd. gingham @ 23c., 25 yd. flannel @ 37c., $18\frac{1}{3}$ yd. tweed @ $1.50, $12\frac{1}{2}$ yd. serge @ $1.75, $6\frac{1}{2}$ yd. broadcloth @ $4.50.

(5) A merchant purchases sugar at $7.50 per cwt.; at what price per pound must he sell it in order to gain 10%?

(6) Find the simple interest on $167 for 3 yr. 9 mo. at 7% per annum.

(7) In what time will any sum of money double itself at 6% simple interest?

(8) $1,200 is to be divided between two persons, *A* and *B*, so that *A*'s share is to *B*'s share as 2 to 7.

(9) At what two times between 3 and 4 o'clock are the hands of a watch equally distant from the figure III.?

(10) A man having $720 spends a part of it, and afterwards received $7\frac{1}{2}$ times as much as he spent; he then had $1,305. How much did he spend?

December, 1885.

(1) Define the following terms:—Factor, Prime Number, Multiplication. Write down all the Prime Factors of 2,310.

(2) (*a*) Reduce to simplest form:—$\frac{9534}{15663}$.

(*b*) What is the least number from which 1,224 and 1,656 may each be taken an exact number of times?

(3) A man who lost $\frac{1}{3}$ of his fortune in one year, and $\frac{3}{7}$ of the remainder the next year, had \$900 left. Find the amount of his fortune at first.

(4) What quantity taken from $159\frac{1}{7}$ will make it exactly divisible by $12\frac{5}{8}$?

(5) Express 3·74976 min. as the decimal of a week.

(6) What will 11,750 ft. of lumber cost at \$27.50 per thousand?

(7) Name the units of length, time, and sterling money.

(8) Find the simple interest on \$800 for 3 yr. at $5\frac{1}{2}\%$.

(9) A cistern has three pipes; the first will fill it in 10 hr., the second in 12 hr., and the third in 15 hr. In what time will they together fill the cistern?

July, 1886.

(1) (*a*) Multiply the sum of forty-eight thousand six hundred and thirty-nine, and thirty-nine thousand five hundred and thirty-seven by their difference and divide the product by sixty-four.

(*b*) The product of four numbers is 827,658,432; the first number is 12, the product of the second and third is 144. Find the fourth.

(2) Make out a bill of the following articles:—$28\frac{1}{2}$ yd. flannel @ 68c., 35 yd. calico @ 15c., $3\frac{1}{2}$ doz. pairs of stockings @ \$2.10, 7 pairs of gloves @ 90c., $12\frac{1}{3}$ yd. linen @ \$1.12, 4 pairs of muslin curtains @ \$4.20.

(3) What will it cost to fence a lot 49 ft. front and 180 ft. depth at \$1.15 per foot?

(4) (*a*) A horse worth \$170 and 3 cows worth \$36 each were exchanged for 14 calves and \$82. Find the value of a calf.

(*b*) A farmer sold an equal number of horses, cows and calves, receiving \$3,540 for the whole. Valuing a horse at \$69, a cow at \$37 and a calf at \$12, find the number of each.

(5) (*a*) What sum of money will produce $300 interest in $2\frac{1}{2}$ yr. at 6% simple interest?

(*b*) At what rate per cent., simple interest, will a sum of money amount to 3 times itself in 25 yr.?

(6) Divide $1,000 among *A*, *B*, and *C*, so that *A* may have $60 more than *B*, and twice as much as *C*.

(7) Five men can do a certain piece of work in 20 dy.; after working 15 dy. they are joined by another man, and the whole work is completed in 19 dy. What fraction of the work is done by the sixth man?

(8) In a 440-yd. bicycle race *A* can give to *B* 20 yd. start, and to *C* 30 yd. *B* and *C* ride a 440-yd. race, starting even. By how much does *B* win?

December, 1886.

(1) Simplify $\frac{1}{2} - \frac{2}{3}$ of $\frac{5}{8} + \frac{7}{7 \cdot 8}$, and find how many times the result is contained in $\frac{2}{5} \div (\frac{7}{9}$ of $\frac{3}{14} - \frac{1}{8})$.

(2) Divide the product of ·037 and ·0025 by the sum of ·9, ·02 and ·005.

(3) If a road is 4 rods wide, how many miles of it will make 10 ac.?

(4) A lot 150 ft. long and 100 ft. wide is to be surrounded by a close board fence 6 ft. high; what will the boards cost at $12.50 per thousand feet?

(5) A farmer bought a number of horses and cows for $2,000. There were three times as many cows as horses, and a horse cost twice as much as a cow. If each horse cost $80, how many cows did he buy?

(6) A man has a salary of $400 per year and has $500 in the bank. If he spends $500 per year, in what time will his money be all gone?

(7) What will $1 amount to in 3 yr. 219 dy. at $7\frac{1}{2}$% per annum?

(8) A man borrows $900, for the use of which he has to pay $3 per month; how long will he have had it when the interest is 50c. on every dollar borrowed?

(9) A dealer sold an article for $8.10 and lost 10%; at what selling price would he have gained 10%?

(10) How can you tell, without actually dividing, whether a number can be divided by 9 without leaving a remainder?

(11) If a cow gives 12 qt. 1 pt. of milk every day and 1 lb. 8 oz. of butter can be made from 25 qt. of milk, how many pounds of butter can be made in 1 wk. from the milk of 16 cows?

(12) A man bought a quantity of tea supposed to be done up in packages of 1 lb. each, for which he was to pay $64; on weighing them, however, it was found that each package was 1 oz. too light; how much should he pay for the tea?

July, 1887.

(1) What multiple of 595 divided by 595 gives as quotient 595?

(2) Find the L. C. M. of $2, $3, $4, $5, $10, $20, $50, and $100.

(3) A man owns $\frac{3}{5}$ of $\frac{5}{6}$ of $\frac{7}{10}$ of an investment; on selling $\frac{3}{7}$ of his share he finds himself worth $100 less than before; what is the value of the whole investment?

(4) Change $\frac{1}{13}$ of $\frac{1}{3} + \frac{1}{3 + \frac{1}{4}}$ to a simple fraction.

(5) What principal will amount to $840 in 5 yr. at $4\frac{1}{2}\%$?

(6) If 1 lb. of thread makes 3 yd. of linen $1\frac{1}{4}$ yd. wide, how many pounds would make 45 yd. of linen 1 yd. wide?

(7) A man sold two farms for $3,000 each; on one he gained 20%, and on the other he lost 20%. Did he gain or lose on the whole and how much?

(8) If a garrison of 1,000 men have provisions for 12 mo., how long will the provisions last if at the end of 2 mo. they be reinforced by 500 men?

(9) A merchant sold a piece of cloth for $24 and thereby lost 25%. What per cent. would have been the gain had he sold it for $34?

December, 1887.

(1) Ten cents will buy 3 oranges, 4 lemons or 5 apples; how many apples are worth as much as 5 doz. oranges and 7 doz. lemons?

(2) A man can run 100 yd. in 10 sec. How many miles will a steamboat go in $5\frac{1}{2}$ dy. at the same rate?

(3) Find the interest on $150 from the 16th of July to the 9th of December, at 5% per annum.

(4) A person borrows money for 6 yr. at $3\frac{1}{2}\%$ and repays at the end of the time, as principal and interest, \$847; how much did he borrow?

(5) A map is drawn to a scale of half an inch to a mile, how many acres are represented by a square inch on the map?

(6) One workman charges \$3 for a day's work of 8 hr., and another \$3.50 for a day's work of 9 hr. Which had I better employ and how much shall I have to pay him for work that he can do in a fortnight working 6 hr. per day?

(7) Water in freezing expands 10%. If a cubic foot of water weighs 1,000 oz., find the weight of a cubic foot of ice.

(8) A merchant bought 1,000 yd. of carpet at 60c. per yard, and sold $\frac{2}{5}$ of it at a profit of 30%, $\frac{1}{2}$ at a profit of 20%, and the rest at a loss of 20%. How much did he receive for the carpet?

(9) A piece of land is surrounded by a stone wall 8 ft. high, and 2 ft. thick; the land inside the wall is 100 ft. long and 50 ft. wide; how many cubic feet of stone does the wall contain?

(10) A house and lot are together worth \$2,100; $\frac{1}{4}$ of the value of the house is equal to $\frac{1}{3}$ of the value of the lot; find the value of each.

(11) A cubical cistern is 5 ft. deep; how many gallons of water will it hold if 277·274 cubic inches make a gallon?

July, 1888.

(1) Prove the rules for division (*a*) of vulgar fractions, (*b*) of decimals, using as examples $\frac{3}{4} \div \frac{5}{7}$ and $\cdot 012 \div \cdot 6$.

(2) A produce merchant exchanged $48\frac{3}{5}$ bush. of oats at $39\frac{3}{4}$c. per bushel, and $13\frac{1}{2}$ barrels of apples at \$3.85 per barrel, for butter at $37\frac{1}{2}$c. per pound; how many pounds of butter did he receive?

(3) A train going 25 mi. per hour starts at 1 o'clock p.m. on a trip of 280 mi.; another going 37 mi. per hour starts for the same place at 12 min. past 4 o'clock p.m.; when and where will the former be overtaken?

(4) If in a certain town \$3,093.75 was raised from a $\frac{3}{4}\%$ tax, what was the value of the property in the town?

(5) By selling my cloth at \$1.26 per yard I gain 11c. more than I lose by selling it at \$1.05 per yard; what would I gain by selling 800 yd. at \$1.40 per yard?

(6) How many thousand shingles, 18 in. long and 4 in. wide, lying $\frac{1}{3}$ to the weather, are required to shingle the roof of a building 54 ft. long, with rafters 22 ft. long, the first row of shingles being double?

(7) A farmer employs a number of men and 8 boys; he pays the boys 65c. and the men $1.10 per day. The amount that he paid to all was as much as if each received 92c. per day; how many men were employed?

(8) A field, whose length is to its width as 4 to 3, contains 2 ac. 2 rd. 32 rods; what are its dimensions?

(9) A man having lost 20% of his capital is worth exactly as much as another who has just gained 15% on his capital; the second man's capital was originally $9,000. What was the first man's capital?

December, 1888.

(1) Write down neatly the following statement of six weeks' cash receipts; add the amounts vertically and horizontally, and prove the correctness of the work by adding your results:—

	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Total.
1st.	$29.87	$31.47	$33.35	$35.00	$26.16	$48.17	.....
2nd.	27.38	30.05	28.39	34.83	27.67	49.99	.....
3rd.	19.96	29.70	29.98	36.10	25.49	47.30	.....
4th.	23.19	32.73	31.80	37.91	27.84	50.00	.....
5th.	17.84	31.19	27.36	35.55	28.10	53.94	.....
6th.	12.09	26.07	24.09	31.87	29.15	57.77	.....
Total	.....	.....	.....	.....	.....	.....	.....

(*No marks will be allowed for this question unless all the work is correctly done.*)

(2) If you buy 3 lb. of butter at 28c. per pound, 5 lb. of tea at 56c. per pound, 6 bars of soap at 17c. per bar, 12 gal. of oil at 27c. per gallon, and 3 oranges at 40c. per dozen, and the merchant throws off 10c. for each dollar's worth purchased, how much change would you get out of a $10 bill?

(3) Divide $82.60 among 27 men and 37 boys, so that each man may have three times as much as each boy.

(4) Find the interest on $387.56 from March 18th to November 19th, at 6% per annum.

(5) A bushel of potatoes weighs 60 lb. If a grocer buys a ton of potatoes for $15, and sells them at 15c. per peck, how much per cent. will he gain?

(6) A barn 80 ft. long and 60 ft. wide is built on a plot of ground 308 ft. long and 204 ft. wide. The rest of the plot is covered with cordwood to a depth of 8 ft. How many cords of wood are there?

(7) The interest on $870 for 4 yr. 6 mo. is $274.05; how much will $1,000 amount to in 3 mo. at the same rate?

(8) A lot 11 rods long and 9 rods wide has a fence built round it. Outside the lot at a distance of 2 ft. from the fence a sidewalk 4 ft. wide is built; how many square yards of ground does the sidewalk cover?

July, 1889.

(1) A bushel of wheat weighs 60 lb. and a barrel of flour weighs 196 lb. If 3 lb. of wheat make 2 lb. of flour, how many barrels of flour can be made from 343 bushels of wheat?

(2) Find the interest on $597.50 for 2 yr. 5 mo. 12 dy. at 8% per annum.

(3) *A* and *B* start together and walk in the same direction, *A* at the rate of 4 mi. per hour, and *B* at the rate of 3 mi. per hour. At the end of 7 hours *A* turns and goes back. How many miles will *B* have gone when he meets *A*?

(4) The circumference of a wheel is $\frac{22}{7}$ of its diameter; find the diameter of a waggon wheel that makes 360 revolutions in going a mile.

(5) A town whose population was 10,000 increased 10% every year for 3 yr.; what was its population at the end of that period?

(6) The Map of Ontario recently issued by the Crown Lands Department is drawn on a scale of 8 miles to an inch. On this map the Township of Scott measures $1\frac{5}{16}$ in. in length and $1\frac{1}{8}$ in. in width; how many acres does it contain?

(7) If for $7 I can have the use of $35 for 3 yr. 4 mo., how much a month shall I have to pay for the use of $8,750?

(8) It is required to build a sidewalk a quarter of a mile in length, 8 ft. wide and 2 in. thick, supported by three continuous lines of scantling 4 in. square; what will the lumber cost at $17 per thousand feet?

(9) Write down neatly the following statement of six weeks' cash receipts; add the amounts vertically and horizontally, and prove the correctness of the work by adding your results:—

	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	TOTAL.
1st.	$28.79	$34.71	$35.33	$30.10	$27.97	$47.81	.....
2nd.	23.87	30.03	29.38	33.84	26.77	48.77	.....
3rd.	16.99	27.09	28.77	30.16	24.95	43.07	.....
4th.	29.13	33.72	30.81	39.17	28.47	50.05	.....
5th.	18.47	32.29	26.73	34.45	28.88	54.39	.....
6th.	19.02	27.06	29.04	29.89	29.51	61.93	.....
Totals.	.....	.....	.....	.....	.....	.....	.....

No marks will be allowed for this question unless all the work is correctly done.

December, 1889.

(1) A fruit merchant bought a quantity of apples for $144; he sold half of them for $82.80, thereby gaining 12 cts. per bushel on what he sold. What did the apples cost him per bushel?

(2) Find the interest on $84.25 from April 16th, 1888, to November 4th, 1889, at 7% per annum. (Year = 365 days.)

(3) A pint contains 9,000 grains of barley and each grain is one-third of an inch long. How far would the grains in 17 bush. 3 pk. 1 gal. 1 qt. 1 pt. reach if placed one after another?

(4) An orchard is $24\frac{3}{5}$ rods long and $15\frac{1}{4}$ rods wide. At $1\frac{3}{4}$ cts. per cubic foot what will it cost to dig a ditch around it 3 ft. 9 in. wide and 4 ft. deep.

(5) *A* sold a town lot to *B* and gained $12\frac{1}{2}\%$. *B* sold it to *C* for $306 and lost 15%. How much did the lot cost *A*?

(6) In a room 26 ft. 6 in. long, 16 ft. 8 in. wide, and 12 ft. 3 in. high, there are three windows each $5\frac{1}{2}$ ft. high and 3 ft. wide, and two doors each 7 ft. high and $3\frac{1}{2}$ ft. wide. The base-board is 9 in. wide. How much paper, $\frac{7}{8}$ of a yard wide, will be required to cover the walls and ceiling?

(7) A farmer sells to a merchant 3,015 lb. of hay at $13 per ton, and takes in payment 6 lb. of tea @ 80c. per lb., $22\frac{1}{2}$ lb. of coffee @ 26c. per lb., 33 lb. of sugar @ 12 lb. for a dollar, $32\frac{1}{2}$ lb. of raisins at $18\frac{3}{4}$c. per lb., 14 lb. 13 oz. of bacon at 16c. per lb., and the balance in cash. How much cash does the farmer receive?

(8) Brown purchased $\frac{7}{8}$ of a mill property for $4,064.55 and Smith purchased $\frac{3}{5}$ of the same property at a rate of 5% higher. What did Smith's part cost him, and what fraction of the property remains unsold?

(9) My farm contains exactly 184 ac. 76 sq. rd. $24\frac{1}{2}$ sq. yd. There are 3·85 ac. in garden and orchard, 8·147 ac. of green crop, 76·9 ac. of grain, 23·608 ac. of meadow, 34 ac, of pasture, and the remainder is uncleared bush. What per cent. of my farm is uncleared?

(10) Write down the following statement of six weeks' cash receipts; add the amounts vertically and horizontally, and and prove the correctness of the work by adding your results:—

	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	TOTAL.
1st.	$95.65	$89.24	$59.79	$78.04	$59.37	$98.16	.....
2nd.	71.58	65.41	67.24	62.49	67.02	51.42	.....
3rd.	58.47	57.99	50.60	71.08	82.91	76.89	.....
4th.	69.29	80.07	91.87	93.74	63.36	90.21	.....
5th.	45.81	93.56	82.54	57.96	72.12	67.96	.....
6th.	63.42	77.68	79.18	86.60	87.31	82.75	.....
Totals.	.....	.....	.....	.....	.....	.....	.....

No marks will be allowed for this question unless all the work is correctly done.

July, 1890.

(1) Write down the following statement of six weeks' cash receipts; add the amounts vertically and horizontally, and prove the correctness of the work by adding your results:—

	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	TOTAL.
1st.	$65.95	$24.89	$79.79	$40.78	$37.59	$89.61	.....
2nd.	58.71	41.65	24.67	94.26	70.26	42.51	.....
3rd.	47.58	99.57	50.60	80.71	91.82	89.76	.....
4th.	29.69	70.80	87.91	74.93	36.63	21.90	.....
5th.	81.45	56.93	54.82	96.57	12.72	96.67	.....
6th.	42.63	68.77	81.79	60.86	31.87	75.82	.....
Totals.	.....	.....	.....	.....	.....	.....	.....

No marks will be allowed for this question unless all the work is correctly done.

(2) A boy's age now is one-fifth of his father's. In six years it will be one-third his father's present age. How old is he?

(3) Some Atlantic liners consume 200 tons of coal per day. They average 8 days out and 8 back. In case of accidents they carry a supply for 4 days extra. How many cubic yards of the hold of such a steamer will be occupied with coal for her round trip if each ton is 33 cubic feet?

(4) In a factory 12 men, 16 women and 30 boys are employed. At the end of a week they receive $330.00. A man is paid as much as two women, and a woman as much as three boys. What is the share of each?

(5) A farmer, whose property is assessed at $9,600, pays on the dollar $1\frac{3}{4}$ mills for township rates, $1\frac{1}{4}$ for county rates, $1\frac{1}{2}$ for railway bonus, and $2\frac{1}{2}$ for school rate. How much does he pay in all?

(6) On June 29th, 1890, I borrow $16.50, to be returned April 30th, 1892. With interest at $6\frac{1}{2}$ per cent. what amount must I then pay?

(7) In what time would a field, 80 x 60 rods, pay for underdraining lengthwise, at 2 cents per foot, if the field yield 2 bush., at 66 cents, per acre more than before draining? The drains are 4 rods apart, and the first drain runs down the centre of the field.

(8) If 18 men do $\frac{2}{3}$ of a piece of work in 30 days of 10 hours, in what time should 15 men do the whole, working 9 hours a day?

(9) Two men start from the same point at the same time to walk in the same direction around a block of land $1\frac{1}{4}$ mi. on each side. *A* goes at the rate of 4 mi. and *B* at the rate of 3 mi. an hour. How far will *A* walk before he overtakes *B*?

December, 1890.

(1) Write down the following statement of six weeks' cash receipts; add the amounts vertically and horizontally, and prove the correctness of the work by adding your results:—

	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	TOTAL.
1st.	$84.56	$74.68	$57.92	$78.81	$51.27	$73.28	.....
2nd.	73.55	65.43	81.47	86.57	74.23	36.19	.....
3rd.	91.32	47.62	90.54	64.93	83.57	75.64	.....
4th.	64.39	54.98	76.41	71.46	54.39	46.37	.....
5th.	57.95	49.17	42.86	92.78	67.44	85.16	.....
6th.	78.19	63.58	52.29	63.69	96.08	79.31	.....
Total..	.....	.....	.....	.....	.....	.....	.....

No marks will be allowed for this question unless all the work is correctly done.

(2) A person sold A $\frac{3}{4}$ of his land, B $\frac{4}{5}$ of the remainder, C $\frac{5}{6}$ of what then remained, and received $50 for what he had left at $60 per acre. Find the number of acres he had at first.

(3) A grocer bought 6 cwt. of sugar for $52.10; he used 65 lb. himself and sold the rest so as to make $1\frac{1}{2}$c. per pound profit on the whole quantity. How much per pound did he sell it for?

(4) A starts from Kingston to walk to Belleville, a distance of 45 mi., at $3\frac{1}{2}$ mi. per hour, and B starts from Belleville 3 hr. earlier at $2\frac{1}{2}$ mi. per hour. Where do they meet, and how far will B be from Kingston when A arrives at Belleville?

(5) A note for $162.50, with interest at $5\frac{1}{2}\%$, was given on January 14, 1889, and paid on November 28, 1890. What was the amount paid?

(6) A certain hall 60 ft. long is to be carpeted. It is found that by stretching the carpet lengthwise, any one of four pieces, width respectively $\frac{3}{4}$ yd., 1 yd., $1\frac{1}{4}$ yd., and $1\frac{1}{2}$ yd., will exactly fit the hall without cutting anything from the width of the carpet. If the narrowest piece, worth $1.10 per yard, be chosen, what will it cost to carpet the hall?

(7) I bought a bush farm, 180 rods long by 96 rods wide, at $12.50 per acre. I paid $14.75 per acre for clearing and $1.35 per rod for enclosing the whole farm with wire fencing. Taking into account that I sold the wood for $1,160 and ashes for $17.20, how much has the improved farm cost me per acre?

(8) *A* loaned *B* \$120 for 1 yr. and 8 mo. and received as payment in full at the end of that time \$130.25. What rate per cent. interest did *B* pay?

(9) A farmer sells a merchant 30 bush. of wheat at 90c. per bushel and makes a profit of 20%; the merchant sells the farmer 5 yd. of broadcloth at \$3.60 per yard, 16 yd. of calico at 8c. per yard, and 44 yd. of cotton cloth at 13c. per yard, and makes a profit of 25%. Which gains the more by the transaction and how much?

July, 1891.

(1) Write down the following statement of six weeks' cash receipts; add the amounts vertically and horizontally, and prove the correctness of the work by adding your results:—

	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	TOTAL
1st.	\$75.59	\$62.68	\$59.63	\$62.78	\$37.36	\$91.34	.....
2nd.	82.61	79.81	48.79	92.13	81.78	87.17	.....
3rd.	56.95	49.83	89.64	47.85	78.81	79.68	.....
4th.	91.04	75.16	46.98	39.67	59.76	95.79	.....
5th.	68.17	34.75	77.63	85.94	93.19	86.97	.....
6th.	47.80	81.14	67.19	49.85	48.77	98.99	.....
Total..	.....	.....	.....	.....	.....	.....	.....

No marks will be allowed for this question unless all the work is correctly done.

(2) A note of \$360, drawn April 20, 1890, is paid July 2, 1891, with interest at $7\frac{1}{2}$% per annum. Find the amount paid.

(3) Brooms are bought wholesale at \$20 per gross; what per cent. profit will be made by selling them at 20c. each?

(4) Express, as a fraction of an acre, the sum of the following:—$\frac{1}{2}$ of $\frac{4}{5}$ of $\frac{1}{16}$ of an acre; $\frac{2}{3}$ of $\frac{1}{21}$ of $\frac{6}{65}$ of 100 sq. rods; and $\frac{1}{17}$ of $2\frac{1}{8}$ times 605 sq. yd.

(5) A drover lost ·065 of his flock by wolves, ·105 by disease, and ·27 by theft; he then sold ·75 of what remained, and has 280 sheep left. Find the number in his original flock.

(6) A legacy of \$9,500 is to be divided among *A*, *B*, and *C*, so that *A* will get $\frac{5}{19}$ of the whole, and *B* will get $\frac{3}{4}$ as much as *C*. Find the shares of each.

(7) The difference in weight of two chests of tea is 25 lb.; the value of both at 65c. per pound is $113.75. How many pounds of tea are in each chest?

(8) Find cost of digging a cellar 48 ft. long, 30 ft. wide and 6 ft. deep, at 20c. per cubic yard, and flooring it with Portland cement at 10c. per square yard.

(9) Farmer *B* sold to a merchant the following articles to apply on an overdue account of $54.45 :—1,680 lb. of hay @ $15 per ton, 3¾ cords of wood @ $4.80 per cord, 4 barrels of apples @ $2.75 per barrel, 350 lb. of flour @ $2.50 per cwt., 30 lb. 10 oz. butter @ 16c. per pound. Make out the account neatly, showing the balance and to whom due.

July, 1892.

(1) Make out the following account, *neatly* and accurately, in *proper form* :—Nicholas Nickleby bought the goods from you on March 3rd, and paid you $10 on account April 8th—3¾ lb. tea @ 80c., 300 lb. sugar @ 4¾c., 45 yd. print @ 11½c., 2¼ gal. syrup @ 65c., 12½ yd. towelling @ 12½c., ¾ doz. knives and forks @ $2.50, 27 lb. cheese @ 15c., 1 lb. 10 oz. lemon peel @ 32c. per lb.

(2) A load of wood, 10 ft. long, 3 ft. 8 in. wide and 3 ft. high, was sold for $3.

(*a*) What was the price per cord?

(*b*) At $4 per cord what would the load be worth?

(3) How much will it cost to paint the outside and both floors of a two-storey cottage, 36 ft. long, 33 ft. wide, and 18 ft. high, at 10c. per square yard. The walls to be 18 in. thick, and no allowance to be made for cornices, openings or partitions?

(4) What amount will be due July 1, 1892, on a note of $80, drawn Feb. 6, 1892, and bearing interest at 5¼% per annum?

(5) What is the smallest sum of money with which you can buy chickens at 25c., or geese at 50c., or turkeys at 75c., or lambs at $3, or sheep at $5, or pigs at $7, or cows at $35, or horses at $140, and have exactly $15 left for expenses?

(6) A farmer agreed to pay his hired man ten sheep and $160 for one year's labor. The man quit work at the end of seven months, receiving the sheep and $60 as a fair settlement. Find the value of each sheep.

(7) What decimal must be taken from the sum of 69⅓, 8·2, 5·445, ·065 and $20\frac{1}{12}$, so that it will contain 6·05 an exact number of times?

(8) A lad earned $21.16 collecting accounts for a physician. He was allowed 5¾%; what amount did he collect?

(9) S. S. No. 5, Esquesing, is assessed for $150,000. The trustees have built a school-house costing $1,800.

(*a*) What will the school-house cost a ratepayer whose property is assessed for $4,500?

(*b*) What would be the *rate* of taxation per annum on the whole section if the house were paid for in six equal annual payments, without interest?

PUBLIC SCHOOL LEAVING EXAMINATION.

1892.

(1) (*a*) What is meant by the Prime Factors of a number?

(*b*) Find the prime factors of 13,230, 22,050, and 23,625, and

(*c*) By means of the prime factors find their G. C. M. and L. C. M.

(2) A man owned $8,940 Bank Stock, which paid a yearly dividend of 4½%. He sold out at 102⅜ and invested the proceeds in Michigan Central Stock at 74⅜ paying a yearly dividend of 3%. By how much was his yearly income changed by the transfer?

(3) Find the proceeds of the following note:—

$2,400.00. Hamilton, February 3, 1892.

Five months after date, value received, I promise to pay Thomas Cowan, or order, the sum of Two Thousand and Four Hundred Dollars, at Bank of Hamilton here, with interest at 6% per annum. VANCE ALLEN.

Dicounted May 22, 1892, at 7%. (Year = 366 days.)

(4) A machinist sold two seed-drills for equal sums of money. He gained 25% on the one and lost 25% on the other. His total loss was $9.60. Find the cost of each drill.

(5) A commission merchant sells a consignment of wheat for $27,500, on a commission of 2½%. He pays $250 for freight and storage, and with the net proceeds buys pork at $6.25 per cwt., charging 2½% for buying. How many cwt. of pork does he buy and what is the amount of his two commissions?

(6) Find the cost of the material required to fence $2\frac{1}{2}$ mi. of railway (both sides), posts placed at 8 ft. apart, an 8 in. base 1 in. thick, a 2 × 4 rail at top, and 6 strands of wire. The posts cost $12\frac{1}{2}$c. each, the lumber $14 per thousand, and the wire 4c. per lb. (A pound of wire stretches one rod.)

(7) (*a*) A circular cistern, 8 ft. in diameter and 9 ft. in depth, is filled with water to the height of 6 ft. How many gallons of water in the cistern? (A cubic foot of water weighs 1,000 oz., and a gallon 10 lb.)

(*b*) If a sphere whose diameter is 4 ft. is submerged in the water in the cistern, how high will it cause the water to rise?

(8) Add vertically and horizontally the following statement of eight weeks' cash receipts:—

	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	T.
1.	$3862.93	$1391.76	$6760.68	$1098.91	$1696.65	$ 43.68	..
2.	396.74	6168.37	864.39	964.26	167.69	1864.86	..
3.	1768.63	467.89	2035.68	3165.03	691.83	785.97	..
4.	3976.98	76.05	364.76	93.68	1948.39	1759.46	..
5.	263.76	1035.84	36.10	386.41	3.45	1396.71	..
6.	1559.83	1932.57	1268.15	8.37	279.72	67.85	..
7.	62.24	318.62	134.36	1763.29	1468.29	543.66	..
8.	194.87	3.85	7643.82	685.38	765.42	39.67	..
T.	.....	.....	.....	.....	.....	.....	..

ALGOMA AND PARRY SOUND.

TEACHERS' EXAMINATION.

(1) Define Factor, Highest Common Factor, Least Common Multiple, Per Cent., Discount, Decimal, Decimal Fraction.

(2) Simplify (*a*) $\frac{10\frac{5}{8} - 7\frac{3}{16}}{12\frac{5}{32} - 9\frac{7}{64}} - \frac{8\frac{2}{9}}{19\frac{5}{27}} \times \frac{12\frac{7}{10}}{16\frac{7}{20}} \div 3\frac{54}{109} + 18\frac{88}{91}$.

(*b*) $7\frac{9}{32} - 8\frac{5}{22} - 12\frac{9}{44} + 7\frac{3}{8} - (5\frac{11}{16} - 6\frac{7}{64} - 7\frac{19}{44} + 10\frac{1}{2} + 15\frac{5}{8})$.

(3) A merchant bought a quantity of cloth at 3 yd. for 1*s.*, and $\frac{1}{10}$ as much at 5 yd. for 2*s.*; and sold the whole at 15 yd. for 7*s.* How many yards at this rate must he sell to clear $1.12? (20c. = 1*s.*)

(4) A and B can do a piece of work in 20 dy.; B and C can do the same work in 25 dy., and A and C in 30 dy. If A and B work 5 dy., and C 20 dy., how long will it take B to finish it?

(5) A speculator loses $\frac{1}{4}$ of his money and then gains \$14; he then loses $\frac{1}{5}$ of what he now has, and gains \$8, when he retires as he began. What amount had he at first?

(6) A merchant has tea worth 30, 40, 80, and 83$\frac{1}{3}$c. per pound respectively; he wishes to make a mixture of 80 lb. so as to sell at 70c. per pound and gain 20% on the cost. How much of each kind must he use?

(7) A broker invested a certain sum of money in railway stock at 88 and paying 6% dividend, and 4 times as much in bank stock at 80 paying 5% dividend; his income from both investments was \$1,400. How much did he invest in each kind of stock?

(8) The amount of two notes is \$400; they are drawn for one year; one is discounted at a bank, the other at true discount. The sum of both discounts is \$38. Money being worth 10%, what is the face of the note discounted at the bank?

(9) How far may a boat, whose speed is 8 mi. per hour in still water, go up a stream whose rate is 4 mi. per hour, so that the round trip may take only 8 hr.?

(10) Two vessels, one in the form of a cube, and the other in the form of a cylinder, together hold 71$\frac{5}{6}\frac{2}{3}$ gal. of water. The diameter of the cylinder is 16 in., and the depth of the side 30 in. If a gallon weighs 10 lb. and a cubic foot 1,000 oz., find the dimensions of the cube.

A.

(1) A set of harness cost \$25, the buggy as much as the harness and 60% of the price of the horse, and the horse as much as the buggy and harness together. Find the price of the rig.

(2) Bought a lot of sheep at \$4 each, as many and 20 more at \$6 each; sold the whole lot at \$5.50 and gained \$30. Find the number bought.

(3) When wheat is worth \$1.20 per bushel, 11 bush. of a mixture of wheat and oats are worth \$8.90, but if the proportions in the mixture were interchanged its value would be only \$8.04. Find the number of bushels of each grain in the mixture, and give the price of oats per bushel.

(4) *A* can chop 4 cords in 3 dy., *B* can chop as much in 3 dy. as *A* in 4 dy. In what fraction of a day can they both together chop one cord?

(5) *A*'s money is $\frac{3}{5}$ of *B*'s; $\frac{1}{3}$ of *A*'s and $\frac{1}{4}$ of *B*'s produces \$800 interest in 6 yr. at 5%. Find the sums.

(6) A father leaves \$3,000 to his three sons, aged respectively $15\frac{1}{2}$, 17 and 19 yr. He directs the money to be invested at 6% simple interest, and the same sum to be given to each son as he reaches the age of 21. Find the cash value of each son's share.

(7) The interest on \$98 for 15 yr. is \$81, part of it being out at 5%, and the rest at 6% simple interest. Find the sum lent at each rate.

(8) A merchant marks his cloth at $3\frac{7}{11}$% profit. After selling $\frac{3}{5}$ of his stock at this rate, he is forced by competition to reduce the price 2c. per yard, and in the end gains only $\frac{11}{15}$ of what he had intended. Find the cost price per yard.

(9) *A* can do a piece of work in 18 dy., *B* in 30 dy., *C* in 33 dy. How long must each work in turn alone so that the work may be completed in 25 dy.?

(10) A building society lends \$1,500 at 5% per annum, compound interest, to be repaid in 10 equal annual instalments, principal and interest together. Find this yearly instalment.

B.

(1) Define Involution, Multiple, and *ad valorem* duty.

(2) A man bought a rectangular farm 140 rods long and 40 rods wide at \$40 per acre. What did it cost?

Criticise the following solution:—140 rods × 40 rods = 5,600 sq. rods ÷ 160 = 35 ac. × 40 = \$1,500.

(3) Two ships sail away from the same port at the same time, one due north at 8 mi. per hour, the other due east at 6 mi. per hour. What distance are they apart in 5 hr., assuming that the surface of the sea is a level surface?

(4) Find the contents of a cone whose altitude is 27 ft. and diameter of the base 20 ft.

(5) If I pay \$1,200 for a 60-dy. draft when exchange is $\frac{1}{2}$% premium and the rate of discount 9%, what is the face of the note?

(6) If my goods had cost me 20% more than they did, my rate of gain would have been less than I now make by 25%. Find my gain per cent.

(7) A has 50% more property than B, and B has 50% more than C; how much per cent. more has A than C? How much per cent. less has C than A?

(8) A bought an organ from B January 1, 1892, agreeing to pay \$160 for it in semi-annual instalments of \$10, the first payment due July 1, 1892. A, however, on second thought decides to pay cash down; what ought he to pay, money being worth 10% per annum?

(9) A man invests \$4,875 in the 3 per cents. at $97\frac{1}{2}$; he afterwards sells out at 99 and re-invests the money in railway shares at 110 paying a 4% dividend. Find the increase in his income.

(10) The capital of a railway company is five million; the gross earnings are half a million, and the expenses are 55% of the earnings. What dividend per cent. can the company pay on the capital?

C.

(1) State and prove the rules for multiplying and dividing decimals.

(2) Simplify $\frac{2}{5}(3\frac{1}{3}+1\frac{1}{4})$ £ $+\frac{1\frac{1}{8}-\frac{1}{3}\text{ of }1\frac{5}{6}}{\frac{1}{20}\text{ of }3\frac{1}{3}+\frac{1\cdot3}{1\cdot4}}\times\cdot475\text{ of }5s.+\frac{4.2}{\cdot012}d.$

(3) The value of the paper on the walls of a room is \$10.35 when the paper is 27 in. wide and 9c. per yard; find the value if paper 2 ft. wide at 8c. per yard be used.

(4) The L. C. M. of two numbers is 634,938,944,494, their G. C. M. is 9187; one number is 85,044,059, find the second number.

(5) A grocer has 630 lb. of a mixture containing chicory and coffee in the proportion of 3 to 4. What amount of coffee must be added to the mixture to make the proportion 7 to 10?

(6) A person discounts a note (true discount) due in 15 mo., so as to make 10% per annum on his money; what per cent. on the face of the note does he exact?

(7) A retired farmer invests 40% of his capital in $3\frac{1}{2}$% stock at 90 and the remainder in 4% stock at 95, and his income is \$1,340 per year. What capital has he invested?

(8) A man bought property for \$9,000, and agreed to pay the principal and compound interest in four equal annual payments. Find the amount of each payment, interest being taken at 6% per annum?

(9) Find the solid content of a hollow spherical shell whose internal diameter is 5 in., the metal being 1 in. thick.

(10) A man standing on the side of a river observes that the reflection of the top of a tower on the other side, is seen by him at a point 29 yd. from the bank on which he stands. He finds also that his eye is 5 ft. above the water and that the river is 1,400 ft. wide. Assuming that the angle of incidence is equal to the angle of reflection, find the height of the tower in feet.

D.

(1) Add together and simplify $\frac{5}{11}[\frac{3}{20} + \frac{3}{4}(\frac{4}{5} - \frac{2}{5})]$ of £1, and $\frac{1}{7}$ of $1\frac{2}{3}$ of $14\frac{7}{11}$ of a penny. Answer to be reduced to £ *s.* *d.*

(2) Express the square root of $(\cdot0864 \times 753) \div \cdot00391$ correctly to the nearest integer.

(3) Express $(1\cdot\dot{5}47\dot{6} \times 10\cdot618) \div 2\cdot\dot{6}\dot{5}4\dot{7}$ in simplest form.

(4) A reduction of 20% in the price of apples would enable a purchaser to obtain 120 apples more for $1. How many apples can be bought for $5 at the first rate?

(5) Divide $100 among a man, a woman, a girl, and two boys, so that the man may have as much as the girl and the two boys, the woman and the girl as much as the two boys, and the man and the girl half of the whole sum.

(6) A merchant lays out £1,000 in buying cloth in England at 3*s.* per yard; he takes the cloth to France at an expense of 3*d.* per yard for freight, packing, etc., and pays a duty of 42 centimes per metre. He sells $\frac{1}{2}$ the cloth at 8 francs, and $\frac{1}{2}$ at 6 francs per metre. Find his profit in sterling money, taking £1 = 25 francs; 1 metre = $39\frac{3}{8}$ inches.

(7) The interest on a sum of money for 2 yr. is $349.58, and the discount for the same sum for the same time is $310.74; simple interest in both cases. Find the rate per cent. and the time.

(8) A dealer sent 5,000 bush. of wheat to his Montreal agent to be sold at $1.20. For his service the agent deducts a commission, and also a 4% commission in advance on the ensuing purchase of silk which he ships to his employer. The two commissions amounted to $500; find the rate of the first one.

(9) A cylindrical vessel contains 3 cub. ft. of water and its depth is 18 in.; find the diameter of the base.

(10) A perpendicular 10 yd. long drawn from the right angle of a triangle divides the hypothenuse in the ratio of 1 to 4. Find the area of the triangle.

E.

(1) Define the terms Abstract and Concrete as applied to numbers. Is $6 \times 3 = 18$ a correct solution of the question:—What will be the cost of 6 postage stamps at 3c. each?

(2) Define the Numerator and the Denominator of a fraction, and *from your definition* prove $\frac{3}{4} \div 5 = \frac{3}{20}$.

(3) Prove the rule for pointing off the number in the extraction of the square root.

(4) What sum of money placed at $5\frac{6}{40}\%$ per annum, simple interest, will yield in 15 yr. as much interest as \$500 will produce in 3 yr. at 5% compound interest?

(5) A bank wishes to realize 4% interest on its discounting operations. Form a table of the rates at which it must discount notes payable in 30, 60 and 90 dy. respectively, days of grace included, and 1 yr. considered = 360 dy.

(6) *A* can give *B* 10 yd. start, and *C* 21 yd. in a race of 120 yd.; *B* can give *C* $1\frac{1}{2}$ seconds' start over the same course. Find the number of seconds in which each of them can run a mile at the same rates.

(7) A person invested one portion of \$1,000 in $3\frac{1}{2}\%$ stock at 80, and the rest of it in 5% stock at 112, and his joint income from both was \$44.06¼. Find the amount invested in each kind of stock.

(8) The central part of a room 24 ft. long and 18 ft. wide is covered with carpet 2 ft. wide at 4*s*. 3*d*. per yard. There is a painted margin all round the room 3 ft. wide, and the total cost is £8 11*s*.; what is the cost per square foot for painting the margin?

(9) In a quadrilateral field ABCD, AB = 159 yd., BC = 105 yd., CD = 90 yd., DA = 161 yd., BO perp. on AC = 84 yd. Find the area of the field in acres correct to three places of decimals.

(10) If an iron ball 7 in. in diameter weighs 10 lb., find the weight of one whose diameter is 10 in.

F.

MANITOBA TEACHERS' EXAMINATION.

(1) A person has \$15,566.60 invested in 6% mortgages; he saves each year $\frac{1}{5}$ of his income and adds it to his capital. What will be his income for the fourth year?

(2) A dealer invests \$2,000 in the purchase of 22 horses, pays \$280 for carriages, \$75 for stabling, and $1\frac{1}{2}\%$ for insurance. He loses one horse which the insurance company make good with \$150. At how much per head must he sell the rest of the horses to realise 12% on his investment?

(3) At what rate per cent. will \$1,520 amount to \$1,733.75 in 2 yr. and 3 mo., simple interest?

(4) Three contractors build a road for \$10,000. *A* has 25 men at work for 16 dy. and 30 men for 34 dy. *B* has 40 men for 10 dy. and 45 men for 40 dy. *C* employs 48 men for 50 dy. and he receives \$200 for superintending the work. To how much is each contractor entitled?

(5) A note of \$6,000, dated May 16th, payable in 4 mo. after date, is discounted on July 21st at 6% by giving another note at 90 dy., of which the proceeds at the same rate will just meet the amount due. Find the face of the second note.

(6) Sterling exchange is at $9\frac{1}{2}\%$ premium, find the cost of a draft on London for £416 8*s*. 9*d*., brokerage being $\frac{1}{8}\%$.

(7) The stock of an insurance company sells at $137\frac{1}{4}$ and pays yearly dividends of 10%; brokerage being $\frac{1}{4}\%$, what per cent. on the investment will a purchaser realise?

(8) A miner finds a gold nugget weighing 24 lb. 10 oz. Avoirdupois, which proves to be 18 carats fine. If standard gold 22 carats fine is worth \$17.62½ per Troy ounce, find the value of the nugget.

(9) A railway train runs over $118\frac{1}{4}$ mi. in $4\frac{1}{2}$ hr. It stops 10 min. at one station, $2\frac{3}{4}$ min. at each of 12 other stations, and runs through a tunnel $2\frac{3}{4}$ mi. long at 16 mi. per hour. Exclusive of stoppages, what is the average speed per hour of the train outside the tunnel?

(10) A room 25 ft. long, 16 ft. 6 in. wide, 11 ft. high, has two doors 8 ft. high, 3 ft. 4 in. wide; two windows 8 ft. 4 in. high, 4 ft. wide; and a fire-place 4 ft. 2 in. square. How many rolls of paper 8 yd. long and 1 yd. wide will be required to paper the walls?

G.

(1) Simplify $\frac{3}{5} \times \frac{5}{6} - \frac{3}{8}$ of $\dfrac{7\frac{1}{2} - 5\frac{1}{4}}{1{\cdot}625} \times {\cdot}064743589\dot{}$.

(2) Bought 6 cwt. 3 qr. 21 lb. sugar at £2 16*s*. per cwt., for which I am to pay $\frac{3}{4}$ cash and the balance in soap at $4\frac{1}{2}d$. per pound. What do I pay in money, and how many pounds of soap?

(3) At what time after 3.30 o'clock will the two hands meet for the first time?

(4) A person performs $\frac{5}{8}$ of a piece of work in 11 dy., he then gets help from a man and they finish it in 4 dy. more. In what time could each do it by himself?

(5) Simplify $\frac{\cdot1234 \times \cdot4321 - \cdot01}{\cdot00481346}$, and $\frac{\cdot83 + \cdot0416}{\cdot0025}$.

(6) If brass be composed of 63 parts of copper and 31 parts of zinc, what quantity of brass contains 4 lb. more copper than of zinc?

(7) Two acres of land are contained in a field whose width is 2 chains 80 links. What is the length of the field?

(8) A man left $\frac{5}{8}$ of his property to his eldest son, $\frac{5}{8}$ of the remainder to his younger son, and the rest to his wife. Upon dividing it was was found that the eldest son had \$750 more than the younger. Find the share of each.

(9) What sum must I lend for 10 mo. at $6\frac{1}{2}\%$ per annum, so that I may receive interest to the amount of \$237.50?

(10) If 500 men excavate a harbor basin 800 yd. long, 500 yd. wide and 40 yd. deep in 4 mo.; how many men will be required to excavate a basin 1,000 yd. long, 400 yd. wide and 50 yd. deep in 5 mo.?

H.

(1) A grain dealer bought 1,300 bush. of wheat and sold $\frac{1}{5}$ of it at a profit of 5%, $\frac{1}{3}$ of it at a profit of 8%, and the rest at 12% profit. Had he sold all at a profit of 10% his gain would have been \$16.68$\frac{2}{3}$ more. Find the cost price of the wheat.

(2) The gross annual receipts of a railroad are distributed as follows:—40% for working expenses, 54% to pay a dividend of $3\frac{1}{2}\%$ to stock holders and \$28,350 placed in the reserve fund. Find the amount of the railroad stock.

(3) *A*'s present age is $\frac{9}{7}$ *B*'s, but 34 yr. ago it was $\frac{5}{2}$ *B*'s. Find their present ages.

(4) A boatman rows 5 mi. with the tide in the time he would row 3 mi. against it. But if the current ran $\frac{1}{2}$ mi. per hour more, he would row twice as fast with the tide as against it. Find his rate in miles per hour in still water.

(5) *A* and *B* have each \$4.000. *A* invests in U. S. 5 per cents at 104, and *B* in $3\frac{1}{2}\%$ English Consols at 91. At the end of a year *A* sells out at 102 and *B* at 98. Give the year's income of each and also his capital after selling out.

(6) If I buy a horse for $80 and am allowed 9 months' credit, and I forthwith sell him for the same sum giving 3 months' credit, find my gain per cent., money being worth 8% per annum.

(7) A property of $2,000, consisting of three farms of unequal value, is to be divided equally among three sons. They agree each to take a farm and balance the accounts by money payments. The three farms are valued as 11, 8 and 6; find the payments that require to be made.

(8) The sides of a triangle are 10, 12 and 16 ft.; find the length of the perpendicular on the short side from the opposite angle.

(9) The diagonal of a square is 4 chains; find the area.

(10) If the radius of a sphere is equal to the side of a cube, the solid contents of the sphere are $\frac{4}{3} \times \frac{355}{113}$ the solidity of the cube. A cubic foot of iron weighs 450 lb.; find the diameter of a 68 lb. cannon ball.

K.

(1) What quantity must added to the difference between $5\frac{7}{8}$ and $9\frac{1}{12}$, so that if the sum be multiplied by $4\frac{4}{5}$ the product may be 28?

(2) Select the greatest and the least of the fractions $\frac{188}{3407}$, $\frac{1609}{33961}$, $\frac{1289}{33880}$, $\frac{973}{33773}$.

(3) The areas of three squares are as 1 : 9 : 16, and the second is known to contain 944,784 sq. in.; find the lengths of the sides of the first and the third in yards.

(4) A mother and two children start on a long voyage. At starting the sum of their ages is 35 yr., and are in the ratios of 356 : 39 : 25. At the end of the voyage the mother's age is to that of the eldest child as 728 : 94. Taking 12 mo. = 1 yr., find the time of the voyage in months.

(5) What is the least number of years for which the simple interest on $145.37\frac{1}{2}$ at 4% will be an exact number of dollars?

(6) Find the difference between the simple and the compound interest on $9,902\frac{3}{8}$ for $2\frac{1}{2}$ yr. at $3\frac{1}{2}$% per annum?

(7) If $800 is invested at 5% per annum, and at the end of each year $120 is deducted for expenses; how much of the capital will be left at the beginning of the seventh year?

(8) Jones started from Halifax to Winnipeg and at the same time Brown from Winnipeg to Halifax. Jones reaches W. in 16 hr., and Brown arrives at H. 36 hr. after they met on the road. Assuming uniform rates, find the number of hours each man was on the road.

(9) If 3% stock sells at 99, what should be the present worth of \$150 due in 9 mo. from date?

(10) If a cubic foot of iron weighs 441 lb., find the weight of a 13-inch cannon ball, the metal being 2 in thick. ($\pi = \frac{22}{7}$.)

L.

SECOND PREVIOUS EXAMINATION, CAMBRIDGE.

(1) Find the quotient obtained by dividing the product of the seven whole numbers next in order after 30 by the product of the first seven whole numbers. ANS. 10,295,472.

(2) The circumferences of the large and small wheels of a bicycle are 176 in. and 48 in. respectively. How many more turns will the latter have made than the former if the machine goes a distance of 15 mi.? ANS. 14,400.

(3) Express the difference between $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7}$ and $\frac{1}{2} + \frac{1}{4} + \frac{1}{6} + \frac{1}{8}$ as a vulgar fraction in its lowest terms. ANS. $\frac{89}{280}$.

(4) Multiply ·01019 by 23·04 and divide ·01342 by ·0055. ANS. ·2347776; 2·44.

(5) Express the quotient of ·21 divided by ·011 as a decimal. ANS. $19\cdot\dot{0}\dot{9}$.

(6) Find the cost of 2 tons 3 lb. 5 oz. at 3*s.* 4*d.* per pound (long ton). ANS. £747 4*s.* 4½*d.*

(7) A level tract of land 20 mi. long and ¾ of a mile broad is flooded to a depth of 5 ft. Given that a cubic foot of water weighs 62 lb. find in tons the weight of water on the land (long ton). ANS. 57,872,571⅜.

(8) A sovereign is worth \$4.07 in America, and 25 francs 2 centimes in French money. How many cents will a man lose who changes £15 at the rate of 25 francs for £1? (A franc = 100 centimes; a dollar = 100 cents.) ANS. $4\frac{311}{417}$.

(9) Two men, *A* and *B*, working alone can finish a piece of work in 7 and 8 hr. respectively. If they work at it for an hour alternately, *A* beginning, in how many hours will the work be finished? ANS. 7⅞.

(10) Find the amount of £400 in 2½ yr., reckoning compound interest at 4%. ANS. £441 5*s.* 10·272*d.*

(11) A man buys 5% foreign stock at 40 and sells out at the end of the year when the stock has fallen to 38. What does he gain per cent. on the transaction? ANS. 7½%.

(12) The excess of the present value of a sum due in 1 yr., reckoning interest at 5%, over the present value when interest is reckoned at 6% is 10*s*. Find the sum. ANS. £55 13*s*.

M.

(1) There is a rectangle whose length is $1\frac{1}{2}$ times its width, and which may be planked with boards of lengths 5, 8, or 9 ft., all running parallel to any (the same) side. What is the least size of the rectangle?

(2) If an ounce of pure gold is worth £3 18*s*.; and in a guinea $\frac{3}{8}$ of the weight is pure gold, and the remainder an alloy 50 times less valuable; what is the weight of the pure gold in a guinea?

(3) How much money must be invested in stock at $97\frac{1}{2}$ which pays an annual dividend of 6% to realise an income of $600 per annum?

(4) A person invests $4,500 in purchasing stock at 90 (par value 100). In 3 mo. he sells 30 shares at 95, and in 3 mo. thereafter the remainder at 87. If his money be worth 8%, what does he gain or lose by the transaction, no dividend having been paid on the stock in the interval?

(5) Show that the following is approximately a correct method of calculating interest at 6% for a given number of days:—"Divide the number of days by 6; multiply the quotient by the number of dollars on which the interest is required; and the result is the interest expressed in mills."

(6) A bill due 4 mo. hence is discounted at 7% per annum (true discount), and $1,267 is received for it. What is its face value?

(7) At what rate per cent. will $100 in 3 yr. amount to as much as $120 in 2 yr. at 7%?

(8) A mortgage which is redeemed, principal and interest, by three equal annual payments of $250 each, is to be sold. What should justly be paid for it now, a year before the first payment; interest 7% per annum?

(9) A grocer has teas at 5*s*. and 3*s*. 6*d*. per pound. He mixes them in equal quantities, and sells the mixture at such a price that he gains as much per cent. on one kind as he loses per cent. on the other. What was the selling price, and what does he gain or lose per cent.?

(10) The volume of a solid whose faces are rectangles is 786 cub. ft., and its edges are as the numbers 1, 2, 3. Find the length of these edges.

N.

(1) Simplify $\frac{\frac{1}{3}+\frac{1}{5}+\frac{1}{7}}{\frac{1}{2\frac{1}{2}}+\frac{1}{3\frac{1}{2}}+\frac{1}{4\frac{1}{2}}} \times \frac{1}{7}\frac{3}{1}$ of $7\frac{1}{3}$, and

Reduce 8 oz. 6 dwt. $3\frac{9}{13}$ gr. to the fraction of a pound Troy.

(2) Divide, to 6 decimal places, nine million eight hundred and forty thousand and eighteen 10-millionths, by one hundred and fifty-nine thousand nine hundred and eighty-two 100-millionths.

(3) What will it cost to purchase bricks for a wall 150 ft. long, 6 ft. high, and 18 in. thick, bricks being worth $6.25 per thousand, and each brick being (including mortar) 9 in. long, $4\frac{1}{2}$ in. wide, and 3 in. thick?

(4) "Toronto, Dec. 1, 1876.—For value received I promise to pay A. B. $1,500 one year after date, with interest at eight per cent. per annum." This note is endorsed as follows:—Jan. 23, 1877, $400; Aug. 20, 1877, $500. Find the amount required to pay the note when due (no days of grace).

(5) Explain the terms—Stocks, Shares, Dividends. When is stock at par? At a premium? At a discount?

A man having $25,000 Dominion Bank Stock paying 8% per annum, sells out at 120 and invests in Bank of Commerce Stock, which is at 125, and pays $8\frac{1}{2}$%. Find the alteration in his income.

(6) How much sugar at 8c., 9c., 10c., 13c., and 14c. per pound, must be taken to form a mixture of 400 lb., worth 12c. per pound?

(7) A coin whose weight is $\frac{2000}{6323}$ of an ounce contains 37 parts in 40 of gold, and the rest is silver; gold being worth $17 per ounce, and silver worth $1.10 per ounce, find the value of the coin.

(8) If at Toronto sterling exchange is quoted at $10\frac{1}{4}$, and at Liverpool exchange on Paris is 26 francs 85 centimes per £1, find what a Toronto merchant, remitting through Liverpool, must pay to discharge a debt of 12,000 francs (brokerage included in the above quotations).

(9) If the diameter of a 20c. piece be to that of a 25c. piece as 10 to 11, find the ratio of their thickness.

(10) Two trains respectively 99 yd. and 132 yd. long, and moving on parallel rails, pass each other in $6\frac{3}{4}$ seconds when running in opposite directions; when moving in the same direction the one passes the other in $47\frac{1}{4}$ seconds. Find their rates per hour.

TYPE SOLUTIONS.

The following selected problems are solved in full as types of the questions likely to appear in the public examination papers in Ontario and elsewhere. A careful study of these questions and a thorough mastery of them by frequent reproduction will go far towards training the student in the art of writing out solutions in a limited time. A few written out daily on the blackboard and formally demonstrated will prove an efficient tonic, and will give the confidence and celerity necessary to success. Several problems here given are more difficult than those usually set for the Primary Examination; but the student requires to attack at his leisure more difficult work than he can do under the rigid time limit of an examination. A suitable test is easily given by having a number of these problems written out on slips of paper and then distributing these slips at random to the different members of the class, who then solve them on the blackboard or on paper without any reference to the book. The pupils should do all the work, both problems and solutions:—

(1) A man and his wife would empty a cask of water in 16 dy.; after both had been drinking 6 dy., the woman alone drank for 9 dy. more, and then there were 4 gal. remaining, and she had drunk altogether $3\frac{3}{4}$ gal. Find the number of gallons in the cask at first.

SOLUTION.—She drinks in 15 dy. $3\frac{3}{4}$ gal., or $\frac{1}{4}$ gal. per day;
$\therefore$ " " 16 " 4 " and leaves $3\frac{3}{4}$ gal.
$\therefore$ He " 10 " $3\frac{3}{4}$ " or $\frac{3}{8}$ gal. per day.
$\therefore$ " " 16 " 6 "
$\therefore$ Cask holds 10 gal.

(2) A and B start to run a race; their speeds are as 17 to 18. A runs $2\frac{1}{2}$ mi. in 16 min. 48 sec. B finishes the course in 34 min. Find the length of the course.

SOLUTION.—*Speeds* are as 17 to 18; therefore the *times* are as 18 to 17; hence B runs $2\frac{1}{2}$ mi. in $\frac{17}{18}$ of 16 min. 48 sec.;

or B runs $2\frac{1}{2}$ mi. in 17×56 sec.
or B " 5 " 34×56 "
or B " $\frac{5}{5 \cdot 6}$ " 34 sec.
or B " $\frac{5}{5 \cdot 6} \times 60$ mi. in 34 min. $= 5\frac{5}{14}$ mi.

(3) Find a number which leaves remainders 1, 2, and 3 respectively when divided by 7, 8, and 9; and the sum of the three quotients = 570.

SOLUTION.—$\frac{1}{7}$ of the number = 1st quotient + $\frac{1}{7}$
$\frac{1}{8}$ " " = 2nd " + $\frac{2}{8}$
$\frac{1}{9}$ " " = 3rd " + $\frac{3}{9}$

$\therefore (\frac{1}{7} + \frac{1}{8} + \frac{1}{9})$ of number $= 570 + (\frac{1}{7} + \frac{2}{8} + \frac{3}{9})$

$$\frac{72 + 63 + 56}{504} \text{ of number} = 570 + \frac{72 + 126 + 168}{504}$$

$\therefore$ 191 times number $= 570 \times 504 + 366 = 287{,}646$,
$\therefore$ number $= 287{,}646 \div 191 = 1{,}506$.

(4) The average of ten results was 17·5; that of the first three was 16·25, and of the next four 16·5; the eighth was 3 less than the ninth, and 4 less than the tenth. Find the tenth.

SOLUTION.—Average of 10 Nos. = 17·5; $\therefore$ their sum = 175
" 3 Nos. = 16·25; $\therefore$ " = 48·75
" 4 Nos. = 16·50; $\therefore$ " = 66·00

$\therefore$ Sum of first seven Nos. $= 48{\cdot}75 + 66 = 114{\cdot}75$
$\therefore$ Sum of last three Nos. $= 175 - 114{\cdot}75 = 60{\cdot}25$
$\therefore$ three times eighth No. $+ 7 = 60{\cdot}25$; $\therefore$ 8th No. $= 17{\cdot}75$
$\therefore$ tenth No. $= 21{\cdot}75$.

(5) To do a piece of work A would require twice as long as B and C together; and B would require thrice as long as A and C together. The three work together and get \$72 for the job; divide the money among them in proportion to their shares of the work.

SOLUTION 1, by Arithmetic.—A, B and C do the work and A does $\frac{1}{2}$ as much as B and C,

$\therefore \frac{2}{3}$ (B and C's work) = job,
$\therefore$ B and C do $\frac{2}{3}$ job, and A does $\frac{1}{3}$ job.

Again B does $\frac{1}{3}$ (A and C's shares),
$\therefore \frac{2}{3}$ (A and C's shares) = job.

$\therefore$ A and C do $\frac{3}{4}$ job; $\therefore$ C does $(\frac{3}{4} - \frac{1}{3})$ job $= \frac{5}{12}$ job.
$\therefore$ B must have done remainder $= \frac{1}{4}$

Thus their shares of the work are $\frac{1}{3}$, $\frac{1}{4}$, $\frac{5}{12}$ respectively, or as 4 : 3 : 5; $\therefore$ their wages are \$24, \$18, \$30.

SOLUTION 2, by Algebra.—

$$\frac{2}{A} = \frac{1}{B} + \frac{1}{C}; \text{ and } \frac{3}{B} = \frac{1}{A} + \frac{1}{C}, \text{ whence}$$

$$\frac{3}{A} = \frac{4}{B} \text{ and } \frac{5}{A} = \frac{4}{C} \text{ or } A : B : C = 3 : 4 : 5 \text{ as before.}$$

N.B.—In all cases *Algebraic Solutions* are accepted on Arithmetic papers in Ontario (see Regulations), so that whenever the solution is easier in the algebraic form the student may substitute an algebraic equation for arithmetical analysis without the least fear of losing marks thereby.

(6) Two sides of a rectangle measured in inches appear to be 11·87 in. and 9·95 in., but measurements are known to be correct only within $\frac{1}{200}$th of an inch each way. Show that the area computed from their product cannot be relied upon beyond the integral part.

SOLUTION.—11·87 × 9·95 = 118·1065. But 11·87 may be anything from 11·87 + $\frac{1}{200}$ to 11·87 − $\frac{1}{200}$ inclusive, *i.e.* 11·8725 to 11·8675,

And 9·95 may vary from 9·9525 to 9·9475 inclusive.

Hence the area may vary from 11·8725 × 9·9525, or 118·16105625 to 11·8675 × 9·9475, or 118·05195625.

Thus the product cannot be relied on beyond the integral part, 118.

(7) A man paid \$1,200 cash for a lot. At the end of a year he took a 90 days' note for \$1,360 in exchange for the lot. Money at 6%; bank discount; 360 dy. = 1 yr.; no days' grace. Find the net gain at the time of sale.

SOLUTION.—90 dy. = $\frac{1}{4}$ yr.; $\frac{1}{4}$ of 6% = 1½%; 1% of \$360 = \$13.60; ½% of it = \$6.80; total, \$20.40 = discount on note.
P. W. of note = \$1,360 − \$20.40 = \$1,339.60
Amount of \$1,200 for 1 yr. at 6% = 1,272.00
Net gain = \$67.60

(8) Two notes, each due in 2 yr.; total face value = \$1,020. First discounted at 5% true; second at 5% bank discount; total proceeds = \$923. Find face value of each. Neglect days of grace.

SOLUTION.—Interest for 2 yr. at 5% = $\frac{1}{10}$ = bank discount; $\therefore$ true discount = $\frac{1}{11}$.

Let V_1 and V_2 be the face values,
$\therefore V_1 + V_2 = 1{,}020$; $\frac{9}{10}V_1 + \frac{19}{20}V_2 = 923$.
Multiply the first by 9 and the second by 10, and $\frac{1}{20}V_2 = 50$,
$\therefore V_2 = 550$, $V_1 = 470$; and the discounts are \$50 and \$47, proceeds \$923.

(9) A pound of tea and 3 lb. of sugar cost 6*s*. But when tea has risen 10% and sugar 50% they cost 7*s*. What would have been the cost if tea had risen 50% and sugar 10%?

SOLUTION.—$\frac{1}{10}$ *more* in the price of tea would require $\frac{1}{11}$ *less* in the weight for the same money; $\frac{1}{2}$ more in the price of sugar would require $\frac{1}{3}$ less in the weight.

Thus,	1 lb.	tea +	3 lb.	sugar	cost	6*s*.	*before* the rise.
$\therefore$	$\frac{10}{11}$ lb.	" +	2 lb.	"		6*s*.	after "
But	1 lb.	" +	3 lb.	"		7*s*.	" "
$\therefore$	$\frac{1}{11}$ lb.	" +	1 lb.	"		1*s*.	" "
or	1 lb.	" +	11 lb.	"		11*s*.	" "
$\therefore$			8 lb.	"		4*s*.	" "
$\therefore$			1 lb.	"		6*d*.	" "

$\therefore$ 1 lb. sugar cost $\frac{2}{3}$ of 6*d*. = 4*d*. before the rise, and 1 lb. tea cost 60*d*. before the rise.
Add 50% to the tea and 10% to the sugar, and the prices are 90*d*. and 4·4*d*.
$\therefore$ 1 lb. tea and 3 lb. sugar cost $90 + 13{\cdot}2 = 103{\cdot}2d. = 8s.\ 7\frac{1}{5}d.$

(10) The fore wheel of a carriage makes six revolutions more than the hind wheel in 120 yd. Increase the circumference of each by 1 yd., and the fore wheel will make only four more revolutions than the hind wheel in the same space. Find by arithmetic the circumference of each wheel.

SOLUTION.—Each circumference multiplied by the number of revolutions = 120. The numbers of revolutions are evidently whole numbers. Now all the divisors of 120 are 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 24, 30, 40, 60, 120, and of these we must choose two that differ by unity, *i.e.*, two of the first six; the other two factors must differ by six, etc. $\therefore$ 4 and 30, 5 and 24 are the only pairs possible. Circumference = 4 yd. and 5 yd.

(11) How many cubic inches of iron are there in a garden roller which is an inch thick, with outer circumference $5\frac{1}{2}$ ft., and width $3\frac{1}{2}$ ft.?

SOLUTION.—Outer circumference = 66 in. $\therefore$ radius = $33 \div \frac{22}{7} = 10\frac{1}{2}$ in. $\therefore$ inner radius = $9\frac{1}{2}$ in. Hence solidity of iron = $\frac{22}{7}\left(\frac{441}{4} - \frac{361}{4}\right) \times 42 = 2{,}640$ cub. in.

(12) A man can borrow money at 6% and pay cash for goods obtaining 2% discount, or he may pay for the goods in 2 mo. What will be the most advantageous course and how much will he gain by it on an invoice of goods amounting to $1,500?

SOLUTION.—2% disct. $= \frac{100}{5000}$; $\frac{49}{50}$ of credit price to be borrowed. 6% for 2 mo. $= \frac{1}{100}$; $\therefore \frac{49}{5000}$ of credit price = interest to be paid.

Gain $= \frac{100 - 49}{5000} = \frac{51}{5000}$ of credit price = $15.30 gain at the end of 2 mo. If the cash gain is meant, we must take the present worth of $15.30, due in 2 mo.

(13) A and B invest capital in the proportion of $3\frac{1}{2}$ to 4. After 5 mo. A withdraws $\frac{1}{2}$ of his capital and B withdraws $\frac{3}{8}$ of his. At the end of the year they have gained $7,090. Find each man's share.

SOLUTION.—The capitals are as 42 : 48.

A's $= (42 \times 5) + (21 \times 7) = 357$
B's $= (48 \times 5) + (16 \times 7) = 352$: Total 709
$\therefore$ A's share = 357, 709ths of $7,090 = $3,570
B's " = 352, " " = $3,520

(14) A lets B have 30 lb. of wool to spin on shares. B is to charge $12\frac{1}{2}$c. per pound for spinning A's yarn and take his pay in wool at 30c. per pound. For every 10 lb. of wool there is a waste of $1\frac{1}{4}$ lb. in spinning. How many pounds of yarn should A receive and how many pounds of wool should B keep in payment of his work?

SOLUTION.—$1\frac{1}{4}$ lb. on 10 lb. is $\frac{1}{8}$ of the whole wasted, $\therefore \frac{7}{8}$ wool becomes yarn, *i.e.*, $\frac{7}{8}$ A's wool at $12\frac{1}{2}$c. = B's wool at 30c.

$\frac{7}{8} \times \frac{25}{30}$ of A's wool = B's wool $= \frac{35}{96}$ A's wool
$\therefore$ A's wool + $\frac{35}{96}$ A's wool = 30 lb. $= 1\frac{31}{96}$ A's wool
$\therefore$ A's wool $= 30 \times \frac{96}{131}$; A's yarn $= \frac{7}{8} \times 30 \times \frac{96}{131} = 19\frac{31}{131}$ lb.
$\therefore$ B's wool $= \frac{35}{96} \times 30 \times \frac{96}{131} = 8\frac{27}{131}$ lb.

(15) A, B and C take a contract for $120, and working together complete the job in $2\frac{2}{3}$ dy. If B had done it alone he would have required $2\frac{2}{3}$ times as long as A and C together; C would have required $4\frac{1}{2}$ times as long as A and B together. Divide the money equitably among them.

SOLUTION.—A, B and C do $\frac{3}{8}$ in a day. Also A and C do $2\frac{2}{3}$ as much work as B in a day.

$\therefore 2\frac{2}{3}$ B's + B's $= \frac{3}{8}$ per day $= \frac{1}{3}$ B's. Hence

B does $\frac{9}{8}$ per day. Again A and B do $4\frac{1}{2}$ times as much as C per day; $\therefore 4\frac{1}{2}$ C's + C's $= \frac{3}{8}$ work $= \frac{1}{2}$ C's.

∴ C does $\frac{6}{88}$ work per day; hence A does $\frac{33}{88} - \frac{15}{88} = \frac{18}{88}$ per day.

Thus the money must be divided as 18 : 9 : 6, or 6 : 3 : 2

∴ A's share = $\frac{6}{11}$ of \$120 = \$65$\frac{5}{11}$

B's share = $\frac{1}{2}$ A's = \$32$\frac{8}{11}$

C's share = $\frac{1}{3}$ A's = \$21$\frac{9}{11}$

(16) I invested a sum of money in debentures at 125 which paid $4\frac{1}{4}\%$ half-yearly; also 44% *more* than that sum in shares at 135, paying $4\frac{1}{2}\%$ half-yearly; and $39\frac{1}{5}\%$ *less* than that sum in stock at 95, paying $3\frac{1}{4}\%$ half-yearly. I found that the income from the shares was \$12.75 less than that from the debentures and stock together. Find the amount invested in each?

SOLUTION.—For 100 invested in debentures, there were 144 shares, $60\frac{4}{5}$ in stock

The investments were as $1 : \frac{36}{25} : \frac{76}{125}$, *i.e.*, as 125 : 180 : 76

The half-yearly returns were ($4\frac{1}{4}$ on 125); ($4\frac{1}{2}$ on 135); ($3\frac{1}{4}$ on 95).

Now $180 = \frac{4}{3}$ of 135, and $76 = \frac{4}{5}$ of 95

∴ returns were ($4\frac{1}{4}$ on 125); (6 on 180) and ($\frac{13}{5}$ on 76) :—

Or returns are as $4\frac{1}{4} : 6 : \frac{13}{5}$:—*i.e.*, $\frac{85}{20} : \frac{120}{20} : \frac{52}{20}$

Hence $\frac{(85 + 52) - 120}{20}$ represents \$12.75

i.e., $\frac{17}{20}$ represents $\$\frac{51}{4}$

or, $\frac{1}{20}$ " $\$\frac{3}{4}$

1 " \$15

∴ 125, 180, and 76 represent \$1,875, \$2,700, and \$1,140 respectively.

(17) A person invests a certain sum (U.S. currency) in U.S. 5's, 10–40, and $70\frac{10}{19}\%$ more than that sum in U.S. 6's, 5–20. The former are at a discount of 5%, and the latter at a premium of 8%, and the interest on both is payable in gold. His interest from the whole investment is \$1,400 in gold. Find the amount of U.S. currency invested in each kind of bonds.

SOLUTION.—$70\frac{10}{19}\% = \frac{67}{95}$, ∴ for every dollar of the first investment there are $1\frac{67}{95} = \frac{162}{95}$ of the second.

In the first 95 produces an income of 5, *i.e.*, $\frac{5}{95}$ per unit.

" second 108 " " 6, " $\frac{6}{108}$ "

∴ $\frac{162}{95}$ produces an income of $\frac{162}{95} \times \frac{6}{108} = \frac{9}{95}$ per unit;

∴ incomes are as 5 : 9, or \$500 and \$900; ∴ investments are \$9,500 and \$16,200 respectively.

(18) Bought goods at wholesale price, but obtained a special discount of 4% on the bill. Gave my note at 6 mo. for the

reduced amount, and sold the goods forthwith for a note at 3 mo. for \$510.51. Money was worth 8% at the time, and my profit on this transaction was $18\frac{2}{11}\%$. What was the wholesale price of the goods?

SOLUTION.—$4\% = \frac{1}{25}$. My note was $\frac{24}{25}$ wholesale price.

Present worth money for 6 mo. at $8\% = \frac{25}{26}$ principal

$\therefore$ present worth of my note $= \frac{25}{26}$ of $\frac{24}{25}$ wholesale price $= \frac{12}{13}$ wholesale price.

My gain was $18\frac{2}{11}\%$, $\therefore$ my selling price was $\frac{13}{11}$ of cost price *i.e.* $\frac{13}{11}$ of $\frac{12}{13}$ wholesale price $= \frac{12}{11}$ wholesale price.

But my selling price was the present worth of \$510.51 for 3 mo. at 8%.

Or, my selling price was $\frac{50}{51}$ of \$510.51 $=$ \$10.01 $\times$ 50 $=$ \$500.50

$\therefore$ my selling price $= \frac{12}{11}$ wholesale price $=$ \$500.50

$\therefore$ wholesale price $= \frac{11}{12}$ of \$500.50 $=$ \$458.79$\frac{1}{6}$.

(19) In 1850 the population of a town was 7,600; in 1870 it was found to be 9,196. If the increase per cent. during the first decade was the same as during the last, what was this per cent.?

SOLUTION.—Let r = decennial rate of increase per unit, just as money increases at compound interest.

$\therefore\ 7{,}600\,(1 + r)^2 = 9{,}196$; $\therefore\ (1 + r)^2 = \frac{9196}{7600} = \frac{121}{100}$;

$\therefore\ 1 + r = \frac{11}{10} = 1 + \frac{1}{10}$; $\therefore\ r = \frac{1}{10} = 10\%$.

(20) A piece of land was bought for \$1,000, to be paid in 5 yr. with interest at 10%. The purchaser was allowed a choice of two modes of payment:—(*a*) To leave the principal unpaid to the end of the fifth year, and pay the interest at the end of each year; (*b*) to pay \$200 of the principal each year together with the accrued interest. Determine which of these modes was the more profitable, and how much the land cost at the end of the period by that mode of payment, money being worth 10% compound interest.

SOLUTION.—1st mode. He pays \$200 per year interest, which is the same as he would pay in principal by the 2nd mode, and as money is worth 10% in both cases, the two methods amount to the same thing.

Cost $=$ amount of \$1,000 for 5 yr. at 10% compound interest.

$= 1{,}000\,(\frac{11}{10})^5 = 1{,}000 \times 161{,}051 \div 100{,}000 =$ \$1,610.51.

SOLUTION No. 2.—Making the settlement at the end of the 5th year, and counting compound interest on all payments, we have the following statement beginning with the last payment:—

Payment.	1st Mode	2nd Mode.	Difference.	
5th	1,100	220	880	in favor of 2nd mode.
4th	100 $(\frac{11}{10})$	240 $(\frac{11}{10})$	154	" 1st mode.
3rd	100 $(\frac{11}{10})^2$	260 $(\frac{11}{10})^2$	193.60	" "
2nd	100 $(\frac{11}{10})^3$	280 $(\frac{11}{10})^3$	239.58	" "
1st	100 $(\frac{11}{10})^4$	300 $(\frac{11}{10})^4$	292.82	" "

But \$154 + 193.60 + 239.58 + 292.82 = \$880. They are the same.

(21) The gross receipts of a railway company in a certain year are apportioned thus:—40% to pay the working expenses, 54% to give the shareholders a dividend of $3\frac{1}{2}$% on their shares; and the remainder, \$42,525, is reserved. What was the paid-up capital of the company?

Solution.—40% + 54% = 94%; 6% receipts = \$42,525 reserve.

$\therefore$ 54% receipts = \$42,525 × 9 = $3\frac{1}{2}$% capital.

Hence $\frac{7}{200}$ capital = \$42,525 × 9;

$\therefore$ capital = 6,075 × 9 × 200 = \$10,935,000.

(22) I have two debts, one of \$400 due in 2 yr., the other of \$2,100 due in 8 yr., both without interest. I wish to give a mortgage without interest for the whole \$2,500. For what length of time should the instrument be drawn, supposing money is worth 5% per annum simple interest?

Solution.—Interest = $\frac{5}{100}$ principal = $\frac{1}{20}$ principal.

$\therefore$ discount = $\frac{1}{21}$ principal. Thus the discount on \$2,100 for a year = \$100; and the interest on \$400 for a year = \$20. Now the interest must be so arranged as to cancel the discount. Hence we see by inspection that *one* way of accomplishing this end is to pay the \$2,100 a year *before* it is due, and \$400 5 yr. after it is due. And this arrangement will exactly coincide with the whole time, viz. 8 yr. Hence the mortgage may be drawn for \$2,500 and allowed to run 7 yr. without interest.

(23) A race in opposite directions round the sides of a right-angled triangle, starting from C, the right angle. The boys run 13 yd. and 11 yd. respectively in a given time, and meet first at D, the middle of AB, the hyp., 2nd at E, a point 30 yd. from C. Find the area of the field.

Solution.—In every 24 yd. covered by both together, the faster runner gains 2 yd. = $\frac{1}{12}$ of whole distance run.

$\therefore$ 30 yd. = $\frac{1}{12}$ perimeter; $\therefore$ perimeter = 360 yd. Now the triangle is right-angled with rational sides, and we see that 36 = 9 + 12 + 15, which are the sides of a right-angled triangle, since $9^2 + 12^2 = 15^2$, hence the sides are 90, 120, 150; and the area = 60 × 90 = 5,400 sq. yd.

(24) Find the effect of adding the same quantity to both terms of a ratio. Employ your results to compare the values of the fractions $\frac{387}{483}$ and $\frac{433}{519}$; $\frac{3731}{4568}$ and $\frac{3798}{4628}$.

SOLUTION.—Book work. A proper fraction is increased in value by adding the same quantity to both terms.

1st case:—$\frac{483}{483} = \frac{519}{519}$, $\therefore \frac{483 - 86}{483} < \frac{519 - 86}{519}$.

2nd case:—$\frac{3731}{4568} < \frac{3731 + 67}{4568 + 67}$ and still $< \frac{3731 + 67}{4568 + 60}$.

i.e. $> \frac{3798}{4628}$, since the fraction is increased in value by decreasing the denominator.

(25) A can do a work in $\frac{1}{2}$ the time B requires, B can do it in $\frac{2}{3}$ of the time C takes. All working together do it in 18 dy. How long would each take separately?

SOLUTION.—A's time : B's time $= \frac{1}{2} : 1 = 1 : 2$

B's " : C's " $= \frac{2}{3} : 1 = 2 : 3$

$\therefore$ A's : B's : C's $= 1 : 2 : 3$

Therefore their rates of work are:—

A's rate : B : C's $= 1 : \frac{1}{2} : \frac{1}{3} = 6 : 3 : 2$

$\therefore$ A does $\frac{6}{11}$ of $\frac{1}{18} = \frac{1}{33}$ per day.

B " $\frac{3}{11}$ " $= \frac{1}{66}$ "

C " $\frac{2}{11}$ " $= \frac{1}{99}$ "

ANS. 33, 66 and 99 dy.

(26) A might have got home in $\frac{4}{5}$ of the time he actually took, if he had only walked $\frac{1}{2}$ mi. per hour faster than he did. Had he, however, gone $\frac{1}{2}$ mi. per hour slower than he did he would have been $2\frac{1}{2}$ hr. longer on the road than he really was. How far had he to walk?

SOLUTION.—1st case: Time $= \frac{4}{5}$ actual time; $\therefore$ rate would have been $= \frac{5}{4}$ actual rate; *i.e.*, increase on actual rate would have been $= \frac{1}{4}$ actual rate $= \frac{1}{2}$ mi. per hour.

Therefore actual rate must have been $= 2$ mi. per hour.

2nd case: Decrease of rate would have been $= \frac{1}{2}$ mi. on a rate of 2 mi. per hour; $\therefore$ decrease of speed $= \frac{1}{4}$ actual rate.

$\therefore$ Decreased speed $= \frac{3}{4}$ actual rate; $\therefore$ increased time on the road $= \frac{1}{3}$ actual time; in other words, the increase of time $= \frac{1}{3}$ actual time $= 2\frac{1}{2}$ hr.

$\therefore$ actual time $= 7\frac{1}{2}$ hr. at 2 mi. per hour;

$\therefore$ distance travelled $= 15$ mi.

(27) An hour after starting a train breaks down, and spends another hour on repairs. Afterwards it runs at $\frac{3}{5}$ of its former rate and arrives 3 hr. behind time. The conductor observes that if the mishap had occurred 50 mi. nearer the terminus, he would have got his train in 1 hr. and 20 min. sooner. Find the length of the trip.

SOLUTION.—Decreased rate = $\frac{3}{5}$ regular rate ; ∴ increased time = $\frac{5}{3}$ regular time ; that is the time lost = $\frac{2}{3}$ regular time = $\frac{4}{3}$ hr. on 50 mi. ;

∴ schedule time = 2 hr. on 50 mi. ;

i.e. schedule rate = 25 mi. per hour ; consequently distance run *before* accident happened = 25 mi.

After the accident—Loss of time = $\frac{2}{3}$ regular time = 2 hr. ;

∴ regular time = 3 hr. ; and regular rate = 25 mi. per hour,

∴ distance after mishap = 75 mi.

∴ whole trip = 25 + 75 mi. = 100 mi.

REMARK.—These solutions illustrate the application of the important principle of *Inverse Ratio*. For any given distance, every increase of speed produces a decrease of time ; and the fractions expressing the rate and the time are mutually reciprocal, and so on for a large number of practical applications of this principle.

(28) What price must I pay for bank stock 3 mo. before the dividend is due, so as to make 9% on my money, the half-yearly dividend being 8% on the par value?

SOLUTION.—Considering 8% half-yearly = 16% per annum, the price of the stock, *without regard to the coming dividend*, would be $100 \times \frac{16}{9} = 177\frac{7}{9}$. But the buyer is entitled to $\frac{1}{2}$ of the half-yearly dividend, viz., \$4 due in 3 mo. The P. W. of this at 9% = $4 \times \frac{400}{409} = 3{\cdot}912$, which must be added to the price of the stock, ∴ total price of stock = $177\frac{7}{9} + 3{\cdot}912 = \$181{\cdot}689$.

N.B.—Eight per cent. half-yearly is = 16 per cent. per annum + interest on \$8 for 6 mo., so that the first assumption is only commercially accurate.

(29) A and B enter into partnership for 3 yr. A puts in \$20,000 and B \$5,000. B is to manage the business, and the profits are to be equally divided ; but at the end of the first year A increases his stock to \$36,000. How shall they divide a gain of \$28,500 at the end of three years?

SOLUTION.—It is evident that B's services are considered equal to \$15,000 capital. Thus A has \$20,000 invested for 1 yr., and \$36,000 for 2 yr. = \$92,000 for 1 yr. ; and B has the equivalent

of \$20,000 for 3 yr. Hence their stocks are as 92 : 60, or as 23 : 15 ; ∴ A's share = $\frac{23}{38}$ of 28½ thousands = $\frac{23}{38} \times \frac{57}{2} \times 1000 =$ $17\frac{1}{4} \times 1000 =$ \$17,250 ; and B's = remainder = \$11,250.

N.B.—B's services are considered \$15,000 capital when the stock is \$25,000. If we consider the value of his services to increase in proportion to the amount of stock in the business, then his services in the second year will be = \$24,600 capital, and his share must be increased in this proportion.

(30) Two quarters of beef weigh altogether 252 lb. ; one cost $7\frac{1}{2}$c. and the other $5\frac{1}{2}$c. per pound. They cost $17\frac{1}{2}$c. more than they would have cost at the average price, $6\frac{3}{8}$c. per pound. Find the weight of each quarter.

Solution by Dr. McLellan.—$6\frac{3}{8}$ is the average of the two prices; if both quarters had been bought at this rate, every pound of first quarter would have cost $\frac{7}{8}$c. *more*, and every pound of second quarter $\frac{7}{8}$c. *less* than was actually paid. And ∴ if the quarters had been of *equal* weight, the cost would have been the same; but the cost was $17\frac{1}{2}$c. *more*, ∴ the first (dearer) quarter was heavier by $17\frac{1}{2} \div \frac{7}{8} = 20$ lb., and $(252 - 20) \div 2 = 116$ the lighter quarter ; 136 the other.

(31) A ditch 120 rods long runs through pure sand and pure clay. If it were all sand A could dig it in 30 dy. and B in 24. But if it were all clay A could dig it in 40 dy. and B in 60. However, A begins at the clay end and B at the sand end at the same time, and they finish in 17 dy. Find how many rods of clay were in the course.

Solution.—A can dig 4 of sand, or 3 of clay
B " 5 " 2 "

Now if B spent the whole 17 dy. in sand, he would do 85 rods. leaving 35 rods for A, who could do this at his slowest rate in less than 12 dy., leaving him idle nearly 5 dy. This shows that B must not spend all his time in sand, but must also do some of the clay. Now when they begin they are approaching at the rate of 8 rods per day; and after B enters the clay they approach at 5 rods per day. Let x = the number of days at 8 rods per day, ∴ $17 - x$ = number at 5 rods per day.

∴ $8x + (17 - x)\,5 = 120$ ∴ $x = 11\frac{3}{5}$ dy.; $17 - x = 5\frac{2}{5}$ dy.

Thus A works 17 dy. in clay at 3 = 51 rods
B " $5\frac{2}{5}$ " " 2 = $10\frac{3}{5}$ = $61\frac{3}{5}$ clay.
B " $11\frac{3}{5}$ " sand 5 = $58\frac{2}{5}$ sand.
120 rods in all.

(32) By T. P. HALL, B.A., Woodstock College.—A, B and C start together round a field whose perimeter is p. A goes a miles, B b miles, C c miles per hour. When will they first be together again?

N.B.—Problems similar to this are occasionally found in papers on Arithmetic, and most Arithmetics give a wrong method of working them.

SOLUTION.—Let x = required time, and let a = highest rate of speed; then ax, bx, cx are the numbers of miles travelled in x hours respectively. Thus we have the equations:—

(1) $ax - bx = mp$; (2) $ax - cx = np$, then m and n are integers, and the smallest integers that will satisfy the two equations.

(1) $\div$ (2) gives $a - b : a - c = m : n$. Now m and n are the smallest integers possible when they are prime to each other.

Let k be the H. C. F. of $a - b$, $a - c$, so that $a - b = km$, $a - c = kn$ $\therefore$ from (1) $x = mp \div (a - b) = p \div k$.

Thus we derive the RULE: To find the time of meeting, subtract the other rates from the highest, and divide the perimeter by the H. C. F. of these differences.

For four travellers we should similarly obtain

$a - b : a - c : a - d = m : n : q$, and as above $x = p \div k$.

EXAMPLE.—If $p = 17$, $a = 20$, $b = 13$, $c = 6$; then $k = 7$, and $x = 2\frac{3}{7}$. So that A would travel $20 \times 2\frac{3}{7} = 48\frac{4}{7}$ mi., B $31\frac{4}{7}$ mi., and C $14\frac{4}{7}$ mi.

(33) In a certain factory were employed men, women and boys. The boys received 3c. per hour, the women 4c., and the men 6c. The boys work 8 hr. per day, the women 9 hr., and the men 12 hr. The boys received \$5 as often as the women received \$10, and the women received \$10 as often as the men received \$24. How many of each were there, the whole number being 59?

SOLUTION.—Each boy gets 24c. per day, each woman 36c., and each man 72c., $\therefore$ their daily earnings are as $2 : 3 : 6$. And the total amounts received by each class are as $5 : 10 : 24$. Hence their numbers must be as $\frac{5}{2} : \frac{10}{3} : \frac{24}{6}$. Dividing 59 in this ratio, we find 15 boys, 20 women and 24 men.

(34) Two partners, A and B, gained \$700 in trade. A's money was 3 mo. in trade and his gain was \$300 less than his stock. B's money, which was \$250 more than A's, was in 5 mo. Find A's stock.

SOLUTION.—Let x = A's stock. $\therefore x + 250$ = B's. And the profits are to be divided in ratio $x \times 3 : (x + 250) \times 5$. Hence we have the equation $\frac{3x}{8x + 1250} \times 700 = x - 300$. Whence $x = 3500$.

(35) Find a decimal multiplier that will convert Troy ounces per inch into tons per mile.

ANS. $\frac{480}{7000} \times \frac{1}{2000} \times \frac{12 \times 3 \times 5\frac{1}{5} \times 40 \times 8}{1}$ converted into a decimal.

(36) If a person spends $\frac{3}{7}$ of his money and \$20 more, then $\frac{7}{9}$ of the remainder less \$20, and has \$28 left, how much had he at the beginning?

SOLUTION.—If he spends $\frac{3}{7} + 20$, he has $\frac{4}{7} - 20$ left.

" " $\frac{7}{9}$ of this $- 20$, he has $\frac{2}{9} + 20$ left;

$\therefore \frac{2}{9}(\frac{4}{7} - 20) + 20 = 28$,

or $\frac{8}{63}$ sum $= 12\frac{4}{9}$, or sum $= \$98$.

OTHERWISE, $\frac{2}{9}x + 20 = 28$, $\frac{2}{9}x = 8$, or $x = 36$, what he had left after first expenditure. $\therefore \frac{4}{7}x - 20 = 36$, $\frac{4}{7}x = 98$, as before.

(37) A commission merchant sold a consignment of goods on 3% commission, and was instructed to invest the proceeds in other goods on 2% commission, both commissions being deducted in advance and amounting to \$265. Find the proceeds of the consignment and the value of the goods.

SOLUTION.—proceeds = commission + goods

Now 1st com. = 3% of proceeds = 3% com. + 3% goods

2nd com. = 2% goods

i.e. whole commission = 3% com. + 5% goods

add 2% com. to each of these equals, and we have

102% com. = 5% com. + 5% goods = 5% proceeds,

i. e. $\frac{102}{100}$ of \$265 $= \frac{5}{100}$ of proceeds. Multiply both sides by 20

and $\frac{102 \times 265}{100} \times 20 =$ proceeds $= \$5,406$

$\therefore$ goods $= 5,406 - 265 = \$5,141$.

(38) By selling out £4,500 in the India 5% stock at $112\frac{1}{2}$, and investing the proceeds in Egyptian 7% stock, a person finds his income increased by £168 15*s*. What is the price of the latter stock?

SOLUTION.—First income $= 45 \times 5$

Second income $= \frac{45 \times 112\frac{1}{2}}{\text{price}} \times 7$

Hence $\frac{45 \times 112\frac{1}{2} \times 7}{\text{price}} - 45 \times 5 = 168\frac{3}{4}$

add 45×5 to both the equals, and

$$\frac{45 \times 112\frac{1}{2} \times 7}{\text{price}} = 168\tfrac{3}{4} + 225 = \frac{1575}{4}$$

Divide both numerators by 45×7, and we get

$$\frac{112\frac{1}{2}}{\text{price}} = \frac{5}{4}.$$ Multiply both sides by 4 price

$$450 = 5 \text{ price}$$

$$\therefore \text{ price} = 90.$$

(39) The difference between the two sides of a rectangular field is 33 yd., and the area of the field is one acre. Find the length of the diagonal.

SOLUTION.—33 yd. = 6 rods, area = 160 rods. Length × breadth = $160 = 2 \times 80 = 4 \times 40 = 5 \times 32 = 8 \times 20 = 16 \times 10$. These are all the integral factors of 160, and the last pair alone differ by 6; ∴ the sides are 16 and 10, and the diagonal is = square root of $16^2 + 10^2 = 18{\cdot}8679623$ rods.

(40) A note for \$876, dated May 17th, for 90 dy. and bearing interest at 8% per annum, is discounted at the bank on July 3rd at 6%. Find the proceeds.

SOLUTION.—The note is legally due on Aug. 18th; 93 dy.
July 3rd to Aug. 18th = 46 dy.
Interest on \$876 for 93 dy. = \$17·856; amount = \$893·856
" " 46 dy. = \$6·759
Proceeds = \$893·856 − \$6·759 = \$887.09.

(41) The expense of constructing a railroad is two million dollars, $\frac{2}{5}$ of which was borrowed on mortgage at 5%, and the remainder was held in shares. What must be the average weekly receipts so as to pay the shareholders 4%, the expenses of working the road being 55% of the gross receipts?

SOLUTION.—Mortgage = \$800,000; stock = \$1,200,000.
Interest on mortgage + int. on stock = \$40,000 + \$48,000 = \$88,000;
∴ 45% receipts = \$88,000 in 52 wk.;
∴ weekly receipts = $(88{,}000 \times 100) \div (45 \times 52)$ = \$3,760.69.

(42) The cost of manufacturing an article depends partly on the cost of the raw material and partly on the cost of labor. Wages rise 25%, but a reduction of $\frac{1}{8}$ in the cost of material enables the manufacturer to produce 16 articles for what 15 cost him before the rise in wages. How much does the raw material for \$100 worth of the manufactured article now cost him?

SOLUTION.—At first, cost = wages + material. (A)
Afterwards, $\frac{5}{6}$ cost = $\frac{5}{4}$ wages + $\frac{5}{6}$ material.
i.e. $\frac{3}{4}$ cost = wages + $\frac{2}{3}$ material. (B)
$\therefore$ (A − B) gives $\frac{1}{4}$ cost = $\frac{1}{3}$ material; or, cost = $\frac{4}{3}$ material.

Now, 2nd cost = $\frac{5}{6}$ of first cost; hence \$100 cost at the altered rates takes the same material as $\frac{5}{6} \times 100$ at original cost, which = $\frac{4}{3}$ material; $\therefore$ material = $\frac{5}{6} \times 100 \times \frac{3}{4}$ = \$80, and this at reduced cost is = $\frac{5}{6}$ of \$80 = \$66$\frac{2}{3}$.

(43) If 12 oxen eat up $3\frac{1}{3}$ ac. of pasture in 4 wk. and 21 oxen eat up 10 ac. of like pasture in 9 wk.; find how many oxen will eat up 24 ac. in 18 wk. ANS. 36. (Proposed by Sir Isaac Newton, 1704.)

NEWTON'S SOLUTION.—If 12 oxen in 4 wk. eat up $3\frac{1}{3}$ ac., then by proportion 36 oxen in 5 wk., or 16 oxen in 9 wk., or 8 oxen in 18 wk., will eat up 10 ac., on supposition that the grass did not grow. But since by reason of the growth of the grass 21 oxen in 9 wk. can eat up only 10 ac., the growth of the grass in 10 ac. for the last 5 wk. will be as much as would be sufficient to feed the excess of 21 oxen above 16, that is 5 oxen for 9 wk., or what is the same thing, to feed $\frac{5}{9}$ oxen for 18 wk. And in 14 wk. the excess of 18 above the first 4, the increase of grass, by analogy, will be such as to be sufficient to feed 7 oxen for 18 wk., for it is 5 wk. : 14 wk. :: $\frac{5}{9}$ oxen : 7 oxen. Wherefore add these 7 oxen, which the growth of grass alone would suffice to feed, to the 8 which the grass without growth after 4 wk. feed, and the sum will be 15 oxen. And, lastly, if 10 ac. suffice to feed 5 oxen 18 wk., then, in proportion, 24 ac. would suffice 36 oxen for the same time.

SOLUTION by A. Martin, M.A., editor *Mathematical Magazine*, Erie, Pa.—In the first case one ox eats $\frac{1}{4}$ of $\frac{3\frac{1}{3}}{12}$ or $\frac{5}{72}$ of an acre and $\frac{5}{72}$ of the growth of that acre in 1 wk. In the second case 1 ox eats $\frac{1}{9}$ of $\frac{10}{21}$, or $\frac{10}{189}$ of an acre, and $\frac{10}{21}$ of what grows on 1 ac. in 1 wk. Since 1 ox eats the same quantity of grass in 1 wk. in each case, therefore $\frac{10}{21} - \frac{5}{72} = \frac{235}{1512}$ of the growth of 1 ac. during 1 wk. is = $\frac{5}{72} - \frac{10}{189} = \frac{241}{1512}$ of an acre; and $\frac{241}{1512} \div \frac{235}{1512} = \frac{1}{72}$ of an acre, what grows on an acre during one week. $\frac{5}{72} + \frac{5}{168}$ of $\frac{1}{72} = \frac{5}{64}$, the part of the original quantity on 1 ac. which 1 ox eats in 1 wk. $\frac{5}{64} \times 18 = \frac{5}{8}$ = quantity of grass, in acres, 1 ox will eat in 18 wk. $24 + (\frac{1}{72} \times 24 \times 18) = 60$ = quantity of grass, in acres, to be eaten from 24 ac. in 18 wk.; and $60 \div \frac{5}{8} = 36$, the number of oxen required to eat it.

(44) In a meadow 20 ac. of grass grows uniformly, and 133 oxen in 13 dy. can consume it, or 28 oxen can eat up 5 ac. of it in 16 dy. How many oxen could eat up 4 ac. of it in 14 dy.?

COLENSO'S SOLUTION.—133 oxen to 20 ac. is $26\frac{3}{5}$ oxen to 4 ac.
28 " 5 " $22\frac{2}{5}$ " 4 "

$\therefore$ 22·4 oxen : 26·6 oxen = 13 dy. : $15\frac{7}{16}$ dy.

i.e. 3 days' growth is eaten by 22·4 oxen in $\frac{9}{16}$ dy.

$\therefore \frac{9}{16}$ dy. : 16 dy. = 3 days' growth : $85\frac{1}{3}$ days' growth.

i.e. original grass = $85\frac{1}{3} - 16 = 69\frac{1}{3}$ days' growth.

$\therefore (16 + 69\frac{1}{3}) : (14 + 69\frac{1}{3}) = 22{\cdot}4 : 25$. ANS. 25 oxen.

(45) The interest already due on a mortgage, together with what acrues during the time, will board 28 people $4\frac{1}{4}$ mo., or 19 $25\frac{1}{19}$ mo. How many people may be supported on this interest and what accrues during the next 12 mo.?

SOLUTION:—

Interest due	+	int. for	$4\frac{1}{4}$	mo.	boards	28	people for	$4\frac{1}{4}$	mo.
$\therefore$ "	+	"	$4\frac{1}{4}$	"		1	man for	119	" (A)
Also, "	+	"	$25\frac{1}{19}$	"		19	people for	$25\frac{1}{19}$	"
$\therefore$ "	+	"	$25\frac{1}{19}$	"		1	man for	476	" (B)
$\therefore$ (B − A);		"	$20\frac{6}{7}\frac{1}{6}$	"		1	"	367	"
		"	1	"		1	"	$17\frac{5}{1}$	" (C)
		"	$4\frac{1}{4}$	"		1	"	$72\frac{2}{3}\frac{9}{1}$	" (D)
$\therefore$ (D − A); Interest due boards						1	"	$46\frac{2}{3}\frac{2}{1}$	" (E)
And, (C); Interest for 12 mo. boards						1	"	$205\frac{7}{3}\frac{9}{1}$	" (F)
$\therefore$ (E + F) Int. due + int. for 12 mo. boards						21	men	12	" ANS.

(46) If 30 ac. of grass pasture 40 horses for 50 dy., and 60 ac. 70 horses for 80 dy., how long will 90 ac. support 100 horses, the grass growing uniformly all the time? ANS. 100 dy.

(47) With the interest already due on a certain mortgage and that which will arise while the work proceeds I can exactly pay the wages of 15 men for 11 mo., or 31 men for 5 mo., wages being uniform per man throughout. Find how long I could engage 9 men on the same plan. ANS. 20 mo.

(48) Two measures from a vessel A and one measure from B produce a mixture of 56 wine and 79 water; but two measures from B and one from A produce 58 wine and 77 water. Find proportion of wine and water in each vessel.

SOLUTION.—Add the two proportions and we have

3 from A and 3 from B give					114	wine	+	156	water	in 270;
$\therefore$ 1	"	A	" 1	" B	" 38	"	+	52	"	90;
But, 2	"	A	" 1	" B	" 56	"	+	79	"	135;
$\therefore$ 1	"	A alone gives			18	"	+	27;	*i.e.*	2 : 3
Similarly 1 from B		"			20	"	+	25;	"	4 : 5

(49) A father left $16,395 to be so divided among his three sons, aged respectively 15, 17 and 25, that when the shares of the two younger put out at simple interest at 5% per annum till they come of age, each would then have an equal amount, and that if one of these shares had been put out at the same rate for the time since the eldest came of age it would amount to his share. Find each share.

SOLUTION.—Suppose $1 is the amount each younger son will have when he is 21 yr. old. Then the youngest should get *now* the P. W. of $1 for 6 yr. at 5% = $\frac{10}{13}$; and the second son should get the P. W. of $1 for 4 yr. = $\frac{5}{6}$; and the eldest gets the amount of $1 for 4 yr. = $\frac{6}{5}$. Hence the present shares are as $\frac{10}{13} : \frac{5}{6} : \frac{6}{5} = 300 : 325 : 468$, and their shares are $4,500, $4,875 and $7,020.

(50) A parcel appears to weigh 49 lb. in one scale of a false balance and 64 lb. in the other. Find the true weight.

SOLUTION.—The longer the arm of the balance the less the weight required to counterpoise the parcel; it is therefore a case of inverse proportion. Hence we have this statement

long arm : short arm = true weight : 49
short arm : long arm = " : 64.
∴ 49 long arm = true weight × short arm; and
64 short arm = " × long arm. Multiply these equations and divide this by long arm × short arm, and we have
64 × 49 = (true weight)²; true weight = 8 × 7 = 56.

(51) From a quantity of gold, silver and copper, weighing altogether 20,300 oz., two alloys are formed; the first in the proportion of 11 gold to 1 copper; the other 37 silver to 3 copper; and there were 288 oz. copper left. The first alloy is coined at the rate of £3 17*s.* 10½*d.* per ounce; the second at 5*s.* 6*d.* per ounce; and the whole sum thus coined is £5,546 14*s.* 6*d.* Find the number of ounces of each metal.

SOLUTION.—20,300 − 288 = 20,012 oz. coined.
£3 17*s.* 10½*d.* = £$\frac{57}{16}$; 5*s.* 6*d.* = £$\frac{11}{40}$; £5,546 14*s.* 6*d.* = 5,546$\frac{29}{40}$. 1st alloy = $\frac{11}{12}$ of gold in it;
∴ 2nd alloy = 20,012 oz. − $\frac{11}{12}$ gold.
Hence $\frac{57}{16} \times \frac{11}{12}$ gold + $\frac{11}{40}$ (20,012 − $\frac{11}{12}$ gold) = 5,546$\frac{29}{40}$
i.e. $\frac{3}{1}\frac{7}{2}$ gold × 579 = 221,869 − 220,132 = 1,737
∴ $\frac{1}{12}$ gold = 1 oz.; gold = 11 oz.
∴ $\frac{37}{40}$ silver = 20,012 − 12 = 20,000; silver = 18,500 oz.
Gold + silver = 18,511; ∴ copper = 1,789 oz.

(52) A and B run a race which lasts 6 min. At the end of the 4th minute A is $\frac{1}{40}$ of the course ahead; at the end of the 5th minute B increases his pace by 20 yd. per minute and wins by 2 yd. Find the length of the course.

SOLUTION.—A gains in 4 min. the $\frac{1}{40}$ of the course
$\therefore$ A " 6 " $\frac{6}{160}$ " "
$\therefore$ 20 yd. $-\frac{6}{160}$ course = 2 yd.
$\therefore$ course = 3 mi.

(53) A, B, C and D run a race over a course of 1 mi. First A and B race, and A beats B by 20 yd. Next C and D race, and C wins by 60 yd. If A and C now race, which will win and by how much, supposing that D could beat B by 40 yd. if they were to run the race?

SOLUTION.—D goes 1,760 while B goes 1,720
$\therefore$ D " 1,700 " B " $1,661\frac{4}{11}$
$\therefore$ C " 1,760 " B " $1,661\frac{4}{11}$
But B " 1,740 " A " 1,760
$\therefore$ B " $1,661\frac{4}{11}$ " A " $1,680\frac{40}{87}$
$\therefore$ C beats A by $79\frac{47}{87}$ yd.

(54) A and B race to a post and back again. In returning A meets B 90 yd. from the post and reaches the starting point 3 min. before him. Had he then returned he would have met B at a distance from the starting point equal to $\frac{1}{6}$ of the distance between the posts. Find A's time in winning the race.

SOLUTION.—Suppose A *had* met B the second time, he would then have traversed the course between the post $2\frac{1}{3}$ times and B $1\frac{5}{8}$ times; A's rate : B's rate = 13 : 11; *i.e.* B loses 2 yd. for every 11 yd. that he goes. But when A met him he had lost 180 yd. and must have gone 990 yd., and he was 90 yd. from the turning post; $\therefore$ distance of course = 990 + 90 = 1,080 yd., and therefore A ran altogether 2,160 yd. and gained $\frac{2}{13}$ of 2,160 yd. But B took 3 min. to run this; $\therefore$ B's rate = $\frac{2}{13}$ of 720 yd. per min. A's rate was therefore $\frac{13}{11}$ of $\frac{2}{13}$ of 720 yd. per min. = $\frac{2}{11}$ of 720 yd. A therefore required 2,160 $\div$ ($\frac{2}{11}$ of 720) = $16\frac{1}{2}$ min. to double the course and win the race.

(55) In a race between two boats a spectator, walking at the rate of 5 mi. per hour, is $\frac{1}{8}$ of a mile ahead of the first boat at starting. When it passes him he observes that the interval between the boats, which was 30 yd. at starting, is reduced to 20 yd. At $1\frac{1}{4}$ mi. from the starting point, the first boat is overtaken by the second. Find the distance traversed by the spectator after the first boat passed him until the end of the race.

SOLUTION.—First, A loses 30 yd. in rowing 2,200 yd.
∴ " 10 yd. " 733⅓ yd.
∴ Spectator has gone 733⅓ − 220 = 513⅓ yd. before he is passed by A. Now 5 mi. per hour = $\frac{440}{3}$ yd. per min.
∴ S goes 513⅓ yd. in 3⅔ min.
∴ A " " " = $\frac{4400}{21}$ yd. per min.
∴ A goes 1¼ mi. in 2,200 ÷ $\frac{440}{21}$ = 10½ min.
∴ S goes 10½ − 3½ = 7 min. at $\frac{440}{3}$ = 1,026⅔ yd. altogether.

(56) Four men, A, B, C, D, undertook a piece of work for £26 10*s.* A could finish it by himself in 4 mo., B in 6, C in 9 and D in 12 dy. But B began work a certain time after A, and C and D a certain time after B. A received £13 3*s.* $11\frac{31}{42}d.$ more than C, and B and D received between them £8 1*s.* $7\frac{7}{22}d.$ How long did A work before B began; how long did B work before C and D began; what did each person receive for his work; and how long was the work in finishing?

SOLUTION.—C received ½ (£18 8*s.* $4\frac{55}{42}d.$) − (£13 3*s.* $11\frac{31}{42}$) = £2 12*s.* $2\frac{8}{22}d.$
∴ A received (£2 12*s.* $2\frac{2}{22}$) + (£13 3*s.* $11\frac{31}{42}$) = £15 16*s.* $2\frac{7}{22}d.$
∴ Time of C and D = £26½ ÷ (£2 12*s.* $2\frac{8}{22}d.$) × 4 = $\frac{39}{44}$ mo.
∴ D received £26½ × (12 ÷ $\frac{39}{44}$) = £1 19*s.* $1\frac{7}{22}d.$
∴ B received £8 1*s.* $7\frac{7}{22}d.$ − £1 19*s.* $1\frac{7}{22}d.$ = £6 2*s.* $5\frac{15}{22}d.$
∴ B's time = (£26½ ÷ £6 2*s.* $5\frac{15}{22}d.$) × 6 = $1\frac{17}{44}$ mo.
∴ A's time before B began = $2\frac{17}{44} - 1\frac{17}{44}$ = 1 mo.
∴ B's time before C and D began = $1\frac{17}{44} - \frac{39}{44} = \frac{1}{2}$ mo.
A worked the full time, ∴ work was completed in $2\frac{17}{44}$ mo.

(57) A and B agree to carry 292 lb. a distance of 3 mi. for 2*s.* They set out with the load suspended from a 6 ft. pole at a distance of 40 in. from A's shoulder, and carry it thus 6 furlongs. After resting they change places and carry it 1¼ mi. farther, when the load slips along the pole to 30 in. from B's shoulder, in which position it was carried to its destination. Neglecting the weight of the pole, divide the money fairly between them in proportion to the work performed.

SOLUTION.—24 fur. for 24*d.* = 1*d.* per furlong. At the end of 6 fur. they changed places, hence at the end of 12 fur. each had earned 6*d.* But for the other 4 fur. before they rested the weight was 32 in. from A and 40 in. from B. ∴ the 4*d.* for this part of the journey should be divided as 40 : 32, *i.e.* A should get $\frac{40}{72}$ of 4*d.* = $\frac{20}{9}d.$, and B should get $\frac{32}{72}$ of 4*d.* = $\frac{16}{9}d.$ In the last stage of 8 fur. the weight is 42 in. from A and 30 in. from B, ∴ the 8*d.* should be divided as 30 : 42, *i.e.* A should get $\frac{30}{72}$ of 8*d.* = $\frac{10}{3}d.$, and B $\frac{42}{72}$ of 8*d.* = $\frac{14}{3}d.$ Thus A gets altogether 6 + $\frac{20}{9}$ + $\frac{10}{3}$ = $11\frac{5}{9}d.$, and B 6 + $\frac{16}{9}$ + $\frac{14}{3}$ = $12\frac{4}{9}d.$

(58) Two cisterns of equal size are full. The tap of one would empty it in 5 hr., the tap of the other in 4 hr. Both taps are opened; when will one cistern have twice as water in it as the other then contains?

SOLUTION.—1st empties $\frac{1}{5}$, 2nd $\frac{1}{4}$ in an hour; difference = $\frac{1}{20}$ per hour.

Suppose a third cistern which empties $\frac{1}{20}$ per hour more than the second, the level of the water in the second cistern will then keep half-way between that in the first and third. Therefore when the third is empty, viz. in $3\frac{1}{3}$ hr., the first will have twice as much water in it as the second has in it.

(59) At what time after 3 o'clock are the hands first equally distant from the figure III.?

SOLUTION.—Suppose the hour hand to move backward at the same rate that it really moves forward. When the hands meet they will be equally distant from III. But the hour hand is now as far above III. as it would in fact have been below III. had it simply moved forward as usual. Hence the time required to meet is the required time.

Now, in 12 min. they approach each other 13 min. spaces,
$\therefore$ " $13\frac{1}{13}$ " " " 15 "

ANS. $13\frac{1}{13}$ min. past 3 o'clock.

(60) Pure gold is worth \$20.62½ per ounce; 18 lb. of a mixture of gold and silver is worth \$3,473.25, but if the silver were gold and the gold were silver in this mixture, it would be worth \$1,278.75. Find the weight of the silver in the mixture and its value.

ANS. 51 oz. silver at \$1.37½ per ounce = \$70.12½.

EXAMINATION PAPERS.

FOR CANDIDATES FOR THIRD-CLASS CERTIFICATES.

1871.

(1) Write in figures and express in words the numbers seven hundred and one units in the 6th period, fourteen in the 5th, one hundred and twenty in the 3rd, fourteen in the 2nd, and nine in the 1st.

(2) Show that the corresponding operation in the simple and the compound rules, are based on the same principles. How many years, months, days, hours and minutes from 20 minutes past 4 o'clock p.m., July 15, 1862, to 25 minutes past 11 o'clock, June 29, 1871?

(3) State the principles on which is based the rule for finding the G. C. M. of two numbers. Apply them to find that of 3,621 and 1,581.

(4) The driving wheels of a locomotive are $17\frac{1}{2}$ ft. in circumference, and the trucks $10\frac{5}{8}$, what distance must the train move to bring wheel and truck into same relative position as at starting?

(5) State the general principles on which the rules of fractions depend; and find the simplest form of $(7\frac{3}{4} \div 5\frac{1}{4})$ of $\{(4\frac{1}{3} \times \frac{7}{8}) + 1\frac{3}{5}\} \times (3\frac{1}{2} - \frac{9}{10})$.

(6) From the sum of $2\frac{1}{2}\frac{2}{4}$ ac., $\frac{2}{3}$ of $3\frac{1}{8}$ ac., $\frac{9\frac{1}{2}}{25\frac{1}{8}}$ roods, and $\frac{3}{11}$ of $1\frac{1}{11}$ per., take 4 ac. 25 per. 12 sq. yd.

(7) A man divided a farm among three sons; to the first he gave 80 ac., to the second $\frac{1}{5}$ of the whole, and to the third $\frac{3}{4}$ as much as to both the others. How many acres did the farm contain?

(8) Find the sum, difference and product of 3·456 and ·425.

(9) Find values of 2·7345 according as the unit is £2 5*s.*, or 5 ac. 2 rd. 10 per., or 6 oz. 10 dwt. 16 gr.

(10) Sold 20,900 ft. of lumber for $\$331.62\frac{1}{2}$, gaining thereby $\$78.37\frac{1}{2}$. What had it cost per C.?

(11) Explain the difference between simple and compound proportion. In Nova Scotia the sovereign is worth \$5, and in Ontario $\$4.86\frac{2}{3}$; convert \$2,720.40 Ontario currency into Nova Scotia currency.

(12) (*a*) Received \$4,100 from my agent, who had deducted his commission at 5%, as proceeds of sale of goods; what were the goods sold at?

(*b*) Remitted \$4,100, including commission, to my agent to invest for me on commission of 5%; what was his commission?

1872.

(1) The demand of 10 hours' pay for 9 hours work is equivalent to a demand of what increase per cent. in wages?

(2) What number divided by $(\frac{2}{9} + \frac{1}{3}) \div (3 - \frac{1}{3}) \times (\frac{1}{3} + \frac{1}{5})$ will give $\frac{3}{14}$ of $\frac{4\frac{5}{9}}{6\frac{1}{6}}$ of $\frac{6\frac{8}{11}}{11\frac{5}{7}}$ of 247?

(3) Find amount of following account:—448 lb. butter @ 23c., 436 lb. cheese @ $9\frac{1}{4}$c., $240\frac{3}{4}$ lb. lard @ $11\frac{3}{8}$c., $254\frac{7}{8}$ lb. tallow @ $13\frac{1}{2}$c., $40\frac{1}{2}$ doz. eggs @ $16\frac{2}{3}$c., 15 barrels salt @ \$1.40, and $481\frac{11}{16}$ lb. ham @ $12\frac{1}{2}$c.

(4) A bankrupt owes four creditors as follows:—*A* \$2,500, *B* \$3,300, *C* \$4,200, *D* \$4,000; his property is worth \$10,500; what does each creditor receive?

(5) A lumber merchant bought 106,250 ft. of lumber at $\$14\frac{3}{8}$ per M., and retailed it at \$1.75 per C. Find his gain.

(6) Find the expense of plastering a room 20 ft. long, $18\frac{1}{4}$ ft. wide, and $11\frac{1}{3}$ ft. high, at 18c. per yard.

(7) If 25 men build a wall 15 ft. high, 2 ft. thick, and 50 ft. long, in 12 dy. of 9 hr. each, how many hours per day must 40 men work to build a wall 60 ft. long, 3 ft. thick, and 20 ft. high in 25 dy.?

(8) How much water must be mixed with 600 gal. wine, at \$2.50 per gallon, in order to make the mixture worth \$2 per gallon?

(9) If \$120 gain \$5.84 in 126 dy., find the gain in 360 dy.

(10) A merchant bought 500 barrels of flour at $6.25 per barrel, on a credit of 8 mo. He sold it at $6.50 per barrel on a credit of 4 mo. What was his net cash gain, money being worth 12%?

1873.

(1) Define a fraction and fully explain the terms Numerator and Denominator.

Simplify $\dfrac{\frac{5}{9} \text{ of } \frac{3}{7}}{6\frac{1}{5} - 5\frac{4}{15}} \div \dfrac{\frac{2}{3} \times 1\frac{1}{2}}{\frac{1}{18} \times 5\frac{1}{2}}$.

(2) Bought $\frac{2}{5}$ of $4\frac{1}{3}$ cords of wood for $\frac{3}{5}$ of $\frac{2}{3}$ of $30; what were 2 cords worth at the same rate?

(3) Show how to convert pure circulating decimals and mixed circulating decimals to vulgar fractions.

Find the sum of $\cdot 4\dot{7}\dot{8}$, $\cdot 3\dot{2}\dot{1}$, $\cdot 3\dot{2}$, $.78\dot{5}6\dot{4}$, $\cdot\dot{5}$, and $\cdot 4326\dot{}$, and the product of $3\cdot 456\dot{}$ by $\cdot 42\dot{5}$.

(4) How many feet of lumber will be required to inclose a building $60\frac{1}{2}$ ft. long, $40\frac{1}{4}$ ft. wide, 22 ft. high, and each side of the roof $24\frac{1}{6}$ ft., allowing $523\frac{1}{4}$ ft. for the gables, and making no deductions for doors and windows?

(5) Find the difference between the true and the bank discount of $2,500, payable in 90 dy. at 7%.

(6) Find cost of plastering the walls of a room $30\frac{1}{2}$ ft. long, $18\frac{1}{2}$ ft. wide, 12 ft. high, at 18c. per square yard (no allowance for openings); find also the cost of carpeting such a room with carpet 27 in. wide, and costing $1.80 per yard.

(7) Ten per cent. of an army was slain on the field of battle, and 5% of the remainder were mortally wounded; the difference between the killed and mortally wounded was 1,100. How many men went into battle?

(8) Having received a stock dividend of 8%, I find I am now the owner of 297 shares; how many shares did I own at first?

(9) Given, that pure water is composed of oxygen and hydrogen in the proportion, by weight, of 15 to 2, find the weight of each in a cubic foot of water.

(10) How many railway shares (100 each) at 40% discount must be sold in order that the proceeds invested in bank stock, which is 4% below par, and pays a dividend of 7%, may yield an income of $1,680?

(11) A railway company pays $24.75 per acre for a portion of road 100 mi. long and $94\frac{1}{2}$ ft. wide; find the whole amount paid.

(12) An insurance company took a risk at $2\frac{1}{4}\%$, and reinsured $\frac{3}{5}$ of the risk at 2%; the premium received exceeded the premium paid by \$42; find the amount of the risk.

1874.

(1) Simplify

$$3\tfrac{1}{2} \times \frac{\frac{1}{4} \text{ of } \frac{5}{6} \times 7\frac{1}{5}}{\frac{1}{3} + 4\frac{1}{2} \text{ of } \frac{4}{7}} + 7\tfrac{1}{2} \times \frac{\left(\frac{2}{5} - 1\frac{1}{6} + \frac{3\frac{3}{4}}{7\frac{1}{2}} + \frac{4}{15}\right)}{\frac{7}{95} + 150\frac{5}{19} - 74\frac{2}{5}} \times 425.$$

(2) Water is composed of two gases, oxygen and hydrogen, in the proportion of 88·9 to 11·1; what weight is there of each in a cubic yard of water (cubic foot of water weighs 1,000 oz.)?

(3) The sum of \$1,416 is to be divided among 15 men, 20 women, and 30 children, in such a manner that a man and a child shall together receive as much as two women, and all the women shall together receive \$480; find the amount received by each man, woman and child, respectively.

(4) A bankrupt who is paying $37\frac{1}{2}$c. in the dollar, divides among his creditors \$6,300: what do his debts amount to?

(5) It costs 96.25 to carpet a room 22 ft. 6 in. long, with carpet 27 in. wide and \$1.75 per yard; find the width of the room.

(6) If 3 men or 5 boys can do a piece of work in 17 dy., in how many days will 5 men and 3 boys do a piece of work three times as great?

(7) Find the cost of 38 yd. 2 qr. 3 nails of cloth when 3·75 yd. cost \$3·825?

(8) A man invests $\frac{1}{2}$ his fortune in land, $\frac{1}{5}$ of it in Bank Stock, $\frac{1}{6}$ in provincial debentures, and loses the remainder (\$8,000) in speculation; what was his fortune at first?

(9) Bought 9,000 bush. of wheat at \$1.12$\frac{1}{2}$ per bushel, payable in 6 mo.; I sold it immediately for \$1.06 per bushel cash, and put the money at interest at 10%. At the end of six months I paid for the wheat; did I gain or lose by the transaction, and how much?

(10) In an examination, Arithmetic and Grammar are valued at 200 marks each; Education, Geography and History at 150 marks each. A candidate obtains 70% in Arithmetic, 65% in Grammar, 60% in Education, 50% in History, and 40% in Geography; find his average rate per cent. (*i.e.* rate per cent. obtained of the aggregate marks).

1875.

(1) Simplify

$$\left\{\frac{\frac{3}{8}+\frac{5}{6}+\frac{7}{8}+\frac{11}{12}}{\frac{3}{4}-\frac{5}{8}}\times\frac{1}{3\frac{1}{2}}\right\}\div\left\{\frac{7\frac{1}{2}}{6\frac{1}{3}}+\frac{11\frac{1}{2}-2\frac{2}{3}}{11\frac{1}{2}+2\frac{2}{3}}\times 10\frac{2}{13}-7\frac{1}{8}\right\}$$

(2) A wine merchant pays \$175 for a hogshead of wine, and bottles it off into an equal number of quart, pint and half-pint bottles; how many dozen of each has he, and at what must he sell it per dozen to gain $\frac{3}{20}$ of his outlay?

(3) What must be the face of a note so that when discounted at a bank for 4 mo. and 9 dy. at 9% it will give \$240?

(4) *A*, *B* and *C* having equal shares of a ship, sell respectively $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{5}$ of their shares to *D*, who dies and leaves his share equally among them; if *B*'s and *C*'s interest in the ship be now worth \$37,300, what is the value of *A*'s share?

(5) A farmer has 500 bush. of wheat; he can sell it at once for \$1.20 per bushel; by storing it for six months at a cost of \$20 paid in advance, he can realize \$1.30 per bushel. He adopts the former course; money being worth 8% per annum, determine how much he has gained or lost by so doing.

(6) Express the value of $\cdot 8\dot{3}$ of 8*s*. + $\cdot 0\dot{5}$ of 2 guineas + $1\cdot 8$ of 5*s*.

(7) A merchant bought a number of barrels of flour for \$1,800; he used 20 barrels and sold $\frac{4}{5}$ of the remainder for \$1,568, which was \$224 more than cost. How many barrels did he buy?

(8) When gold is quoted at $133\frac{1}{3}$, what is the gold value of a \$10 greenback?

(9) A piece of land whose length is 151 yd. $1\frac{1}{4}$ ft., and breadth 35 yd., is to be exchanged for part of a strip of land of the same quality, whose breadth is 15 yd. $2\frac{1}{2}$ ft. Find the length of the equivalent strip.

(10) What is the duty on 4 hogsheads of sugar, each weighing 1,280 lb. gross, at $2\frac{3}{4}$c. per pound; tare 14%?

(11) A merchant in New York wishes to remit to London a bill of exchange for £293 1*s*. 0*d*.; what is the cost of this bill when exchange is at $9\frac{1}{2}$% premium?

1876.

(1) Find what quantity must be added to

$$\left(\frac{1\frac{1}{2}\text{ of }3\frac{1}{3}}{3\frac{1}{2}\text{ of }2\frac{2}{3}}\text{ of }\frac{1\frac{3}{7}\text{ of }1\frac{1}{6}}{1\frac{2}{7}\text{ of }\frac{32\frac{2}{3}}{3\frac{1}{2}}}+\frac{2\frac{1}{8}\text{ of }6\frac{2}{3}}{3\frac{1}{5}\text{ of }4\frac{1}{2}}\right)$$

to make it equal to $\left(\frac{1}{28\frac{2}{7}}\text{ of }3\frac{2}{4}\text{ of }3\frac{1}{7}\text{ of }1\frac{3}{7}\times\frac{1}{5}\right)$

(2) Reduce to its simplest form

$$\frac{(\cdot075)^3 + (\cdot025)^3}{(\cdot075)^2 - (\cdot075)(\cdot025) + (\cdot025)^2}$$

; and divide $9\cdot17\dot{0}4\dot{5}$ by $3\cdot\dot{3}\dot{6}$, giving the result to the end of the first period.

(3) Express $\frac{3}{70}$ of 12*s.* 6*d.* + $\frac{4}{15}$ of 3 guineas + $\frac{5}{12}$ of £4 − $\frac{3}{70}$ of $2\frac{1}{3}d.$, as a fraction of £5.

(4) A merchant marks his goods so that he may allow a discount of 5% and still make a profit of 15%. Find the marked price of broadcloth that cost him $3.80 per yard.

(5) At an election in a constituency in which the number of voters was 1,800, the votes polled by the candidates were in the ratio of 7 to 5, and the successful candidate was elected by a majority of 240. Find the number who did not vote.

(6) A rectangular plot of ground is 60 ft. long and 50 ft. wide; one pathway is made surrounding the plot on the outside, and two others intersecting at right angles in the middle of the plot; if these pathways are 5 ft. wide and cost $62\frac{1}{2}$c. per square yard, find their entire cost.

(7) *A* and *B* engaged in business, the former contributing $7,500, the latter $4,500. The gross receipts for the first year were $2,800, of which 5% was paid for insurance, and $14\frac{2}{7}$% for other expenses; of the balance, *B* received a certain sum for managing the business, and the remainder was divided in proportion to the capital invested. *A*'s share was $1,250; find *B*'s allowance as manager.

(8) At what rate per cent. will $1,520 amount to $1,733.75 in $2\frac{1}{4}$ yr.? Find also in what time $33.40 will double itself at $6\frac{2}{3}$% per annum?

(9) A drover bought 400 sheep at a certain price per head. He sold $\frac{3}{8}$ of them at a gain of 20%, $\frac{3}{10}$ of them at a gain of 15%, and the remainder at a loss of 10%, gaining on the whole $217. How much did he pay for the 400 sheep?

(10) If 3 horses are worth 7 cows, and 5 cows cost as much as 30 sheep, and 16 sheep cost $165, find the value of 12 horses.

1877.

(1) If 69 German Thalers, of which 9 parts in 10 are fine silver, weigh 41 oz., what is the value of a Thaler in English money when standard silver, of which 37 parts in 40 are fine, is worth 5*s.* $1\frac{1}{2}d.$ per ounce?

(2) A, B and C can do a piece of work in 2 dy., A and C in

$$6\left(\frac{7\frac{2}{9}\text{ of }12\frac{2}{3}}{2\frac{8}{9}\text{ of }15\frac{5}{6}}\right) - 3\left(\frac{2\frac{1}{7}\text{ of }4\frac{1}{3}}{2\frac{1}{14}\text{ of }2\frac{1}{2}}\right)\text{ days;}$$

in what time can B do it alone?

(3) A certain kind of brass is made by fusing together old brass, refined copper, and zinc, in the proportion of 33, 55, and 24; how much of each must be taken to produce 170 lb. of brass, after allowing $2\frac{6}{7}\%$ for waste?

(4) March 21, 1877: sterling exchange is quoted at $9\frac{3}{4}$ for demand bills; what must be paid for a demand bill for £18 5*s.*?

(5) What will be the cost of insuring a ship worth $\$48,628\frac{1}{6}$, at $3\frac{1}{8}\%$, so that in case of loss the owner may recover the value of the ship, and the amount paid for insurance?

(6) The numerator of a certain fraction is $\frac{1}{5}$ as much again as its denominator, and the sum of the numerator and denominator is 352. Find the fraction.

(7) A room whose height is 12 ft., and length $1\frac{1}{6}$ times its width, takes $178\frac{2}{7}$ yd. of paper 1 ft. 9 in. wide to cover its walls; what will it cost to cover the floor with carpet 27 in. wide and costing $\$1.75$ per yard?

(8) The L. C. M. of two numbers is 634,938,944,494, and their G. C. M. is 9,187; one of the numbers is 85,044,059; find the other.

(9) The difference between the interest and the discount of a sum of money for 1 yr. and 9 mo., at 8%, is $\$9.80$; find the sum.

(10) A rectangular field whose length is three times its breadth, contains 6 ac. 900 yd.; find its length and breadth.

1878.

(1) Distinguish the terms Multiple, Common Multiple, and Least Common Multiple.

The L. C. M. of 391 and another number is 12,121, and the G. C. M. is 23; find the other number.

(2) Prove that $2\frac{3}{4} \div \frac{3}{5}$ is equal to $2\frac{3}{4} \times \frac{5}{3}$.

Simplify $\dfrac{1\frac{7}{9} + 8\frac{1}{4}}{7\frac{5}{6} - 4\frac{2}{9}} \div \dfrac{2\frac{1}{19} + \frac{7}{38}}{\frac{7}{38} - \frac{7}{76}} \times \dfrac{45\frac{1}{8}}{21\frac{1}{4}}$.

(3) Divide to 6 decimal places nine million eight hundred and forty thousand and eighteen ten-millionths by one hundred and fifty-nine thousand nine hundred and eighty-two hundred-millionths.

(4) Define ratio and proportion. Show that when four quantities are in proportion, the product of the extremes is equal to the product of the means.

Find a fourth proportional to 767 ac. 9 chains 279 yd. 4 ft., 208 sq. mi. 181 ac. 93 yd. 4 ft., $1,317.

(5) Find the ratio of the simple interest to the true discount on a sum of money for a given time and rate.

The interest on a sum of money is $110, and the discount for the same time and rate is $88; find the sum.

(6) How many bricks, 9 in. long, $4\frac{1}{2}$ in. broad, and 4 in. thick, will be required for a wall 60 ft. long, 17 ft. high, and 4 ft. thick, allowing that the mortar increases the bulk of each brick $6\frac{1}{4}\%$.

(7) What is the Square of a Number? The Square Root?

The square of 10,129 is 102,596,641, find the square of 101,293 without going through the operation of squaring.

Extract the square root of $\cdot 047619 \div 1\cdot 199476$.

(8) A man rows 3 mi. down stream in 40 min.; without the aid of the stream it would take him an hour; how long would it take him to return against the stream?

(9) A grocer bought a quantity of tea of a certain quality, and $\frac{1}{4}$ as much of an inferior kind, the cost of the latter per pound being only 80% of that of the former; he mixes them, and sells the mixture at an advance of 10% on the cost per pound of the finer quality; find his entire gain per cent.

(10) A man invests a certain sum of money in railway stock selling at 80 and paying 5% dividends, and 50% more than that sum in Bank of Commerce stock selling at 120 and paying 8%; his income from both investments is $520. Find the amount invested in each kind of stock.

1879.

(1) Show that $\frac{8}{9} = \frac{8}{12}$ and that $\frac{5}{9} = 5 \div 9$.

Simplify

$$\left\{ 2\tfrac{1}{2} \times 4\cdot 75 \div \tfrac{9}{2} \text{ of } (4\tfrac{3}{4} - 3\tfrac{5}{36}) + \frac{1\cdot 75}{3\frac{1}{2}} + \frac{4\frac{3}{10} \times 2\frac{7}{10}}{21\cdot 5 \times 13\frac{1}{2} \div \cdot 25} \right\}$$

of $(3\frac{1}{3} \times \frac{9}{6\frac{2}{3}} \div \dot{9})$ of £5 16*s.* 8*d.*

(2) Explain the rule for "pointing" in division of decimal numbers.

Divide 31·47 by 839·2765 correct to five decimal places, and find the product of 3·706205 by ·0034005 correct to six decimal places. (20 marks if done by contracted methods, otherwise 10 marks.)

(3) Extract the square root of ·097199881 to six decimal places.

Simplify $(\sqrt[3]{\cdot 54} - 23\sqrt[3]{\cdot 0000390625}) \div (\sqrt[3]{\cdot 16} + \sqrt[3]{\cdot 02})$.

(4) A rectangular courtyard, 180 ft. long and 135 ft. wide has a path running round it of the uniform width of 10 ft. 6 in.; the path is covered with gravel at a cost of 22½c. per square yard, and the remainder of the courtyard is covered with turf at a cost of 17½c. per 100 sq. ft.; find the entire cost?

(5) The amount, at simple interest, of a sum of money at a certain rate per cent., is \$693.33 for 8 yr., and \$640.80½ for 5½ yr.; find the principal and the rate per cent.

(6) A grocer mixed two kinds of wine, worth respectively \$2.40 and \$3.20 per gallon, in such a proportion that by selling the mixture at \$2.80 per gallon he made a profit of 10%; find the proportion in which the wines were mixed.

(7) A merchant invested a sum of money in Federal Bank stock at 112, and after receiving a half-year's dividend at 4% he immediately sold out at 115¾; he received altogether from dividend and profit on sale of stock \$310 more than he invested. Find the amount originally invested.

(8) *A* and *B* form a partnership, *A*'s capital being to *B*'s as 5 to 8; at the end of 6½ mo. *A* withdraws 20% of his capital, and a month after *B* withdraws 33⅓% of his capital. At the end of the year the profits are found to be \$3,047; how should this be divided?

(9) A note drawn at 135 dy., with interest at 8% per annum, is discounted by a broker 75 dy. before maturity; the broker gives \$375.80 for the note and makes at the rate of 10% per annum on his money. Find the amount for which the note was drawn.

(10) Ascertain the cost, at \$35.10 per ton of 2,000 lb., of 864 yards of iron piping, 25 in. internal diameter, and ½ in. thick, assuming the specific gravity of iron to be 7·77, and a cubic foot of water to weigh 62½ lb. $(\pi = 3\frac{1}{7}.)$

1880.

(1) Examine the statement "Division is a short method of Subtraction." Apply your answer to illustrate the following examples:—(*a*) Divide \$48 by \$16. (*b*) Divide \$48 by 16. (*c*) Divide \$48 among 16 boys.

(2) Explain clearly the principles involved in finding the sum of two fractions.

Simplify

$$\tfrac{1}{5}(3\tfrac{1}{3}+1\tfrac{1}{4})\text{ of }£1+\tfrac{1}{4}\text{ of }\frac{1\tfrac{1}{8}-\tfrac{1}{3}\text{ of }1\tfrac{5}{6}}{\tfrac{1}{10}\text{ of }3\tfrac{1}{3}+\tfrac{1}{7}\tfrac{3}{2}}\times\cdot95\text{ of }5s.+\frac{2\cdot1}{\cdot102}d.$$

(3) What is the Square of a Number? The Square Root?

Explain why, in extracting the square root of a number, you mark off the number into "periods of two figures each."

Simplify $(3\sqrt{32}-2\sqrt{28})\div(\sqrt{32}-\sqrt{28})$.

(4) Define Ratio, Proportion, and Mean Proportional.

The quantity of saline matter in sea-water is ·036 of the whole weight, and of this weight ·061 is magnesia. Find the number of grains of magnesia in a cubic foot of sea-water, supposing 32 cub. ft. of it weigh 2,000 lb.

(5) Show that "Bank" discount exceeds "True" discount by the simple interest on the True discount.

If \$6 be allowed as true discount on a bill of \$150, having a certain time to run, what would be the discount if the bill had twice as long to run?

(6) *A* and *B* form a partnership, *A* supplying 25% more capital than *B*. At the end of the year *A* withdraws 60% of his capital, and *B* withdraws 40% of his; at the end of 2 yr. there is a gain of \$3,383.50 to be divided. How much does each receive?

(7) A merchant bought 350 yd. of silk and 1,470 yd. of lustre, the price per yard of the lustre being 30% that of the silk; he sold the silk at a gain of 35%, and the lustre at a loss of $33\frac{1}{3}$%, and lost on the whole \$39.20. Find the cost price of the silk per yard.

(8) An agent sold a consignment of flour for \$4,800, and invested the proceeds (less his commission on both transactions) in the purchase of tea, receiving on the latter purchase 4% on the amount invested. His commission on both transactions being \$300, find his rate of commission on the sale of the flour.

(9) Find to six decimal places the average of $2\frac{3}{5}$, 2·37, $3\cdot00\dot{6}$, 0, $2\cdot97\frac{1}{2}$, and $3\cdot5\dot{1}\dot{6}$.

(10) There is a garden-plot in the form of a trapezoid, whose two parallel sides are 40 yd. and 50 yd. respectively, the other sides being respectively 30 yd. and 24 yd. Show that the perpendicular distance between the parallel sides is $\frac{24}{5}\sqrt{11}$.

1881.

(1) Find the L. C. M. of 545, 26,487, 1,853, 11,421.

One kind of brick is $4\frac{1}{2}$ in. long and $2\frac{3}{4}$ in. thick; another 5 in. long and $3\frac{1}{2}$ in. thick. What is the size of the least piece of wall, height being same as length, that can be constructed of either kind of brick?

(2) Define Numerator and Denominator of a fraction, and from your definitions *prove* that $\frac{2}{3} \times 5 = \frac{10}{3}$; $\frac{2}{3} \times \frac{5}{7} = \frac{10}{21}$.

(3) Simplify $\left(\frac{1\frac{2}{5} \text{ of } 11\frac{1}{4} + 1\frac{2}{7} \text{ of } 7\frac{2}{7}}{33\frac{1}{3} - 6\frac{1}{8}} + 8\frac{7}{16}\right) \div \frac{\frac{1}{2} \text{ of } 6\frac{3}{4} - 2\frac{1}{8}}{25 + \frac{1}{7} \text{ of } 3\frac{1}{8}}$.

Add together $\frac{3}{7}$ of 1 wk. 2 dy. 17 hr.; $\frac{4}{5}$ of 17 hr. 23 min. 26 sec., and $\frac{4}{7}$ of 2 dy.

(4) Describe briefly the Metric System of Measures.

If a gallon contain 277 cub. in., and a dekalitre contain 17·6077 pints, express a metre in inches.

(5) If A walk 7 hr. per day, and B 6 hr., and if, under like conditions, B can walk 6 mi. while A is walking 5, how many days will A be walking down hill a distance of which B accomplished up hill in 3 dy.; supposing that a man's rate of walking is increased by $\frac{1}{8}$ in going down hill, and decreased by $\frac{1}{4}$ in going up?

(6) If 1,000 men excavate a square basin whose side is 1,600 yd., and which is 30 yd. deep, in 9 mo., how many will be required to excavate a square basin whose side is 2,000 yd., and which is 40 yd. deep, in 12 mo.?

(7) The hands of a clock move irregularly, the hour hand moving 5% too fast, and the minute hand 10% too slow. In 15 min. (true time) they will be together; how many minutes, measured on the face of the clock, are they apart now.

(8) A money lender has \$1,500 out at 8%, \$1,200 at $7\frac{1}{2}$%, and \$1,000 at 6%; find the percentage he receives on the average.

(9) A mortgage for \$1,000 paying 7% per annum, payable yearly, has 2 yr. to run; what should a loan society give for the mortgage that it may receive 8% on its investment, it being assumed that all money received by the society can be lent out at 8%.

1882.

(1) The fore and hind wheels of a carriage are 9 and 12 ft. in circumference respectively. There are two points, one in each circumference, at present in contact with the ground. Show that as the carriage moves on these points can never at the same time be the highest points of each wheel.

(2) Reduce $\left(\frac{5\frac{1}{5} - \frac{1}{4} \text{ of } 2\frac{2}{7}}{\frac{3}{5} \text{ of } 4\frac{1}{6} + \frac{1}{12}} - \frac{859}{1085}\right)$ of 3 lb. to the fraction of 5 tons.

(3) *Prove* that $\cdot 48732$ is equal to $\frac{48684}{99900}$.

(4) Find the present value of \$320, due 2 yr. hence, at 8% per annum, compound interest.

(5) Find approximately in how many years a given sum of money will double itself at 15% per annum, compound interest.

(6) How large a bill of exchange on Paris can be bought for \$1,500 currency, exchange being at the rate of \$1 for 5·25 francs, and gold being at a premium of $8\frac{1}{2}$%.

(7) On July 10th a banker discounts a note for \$500, made May 10th, at 6 mo., at the rate of 8% per annum. At what rate does he receive interest on his money?

(8) *A* sells an article at a certain advance per cent. on the cost to *B*, who, in turn, at the same advance per cent., disposes of it for \$19, finding that if he had sold for \$13 he would have lost per cent. $1\frac{1}{4}$ of what he now gains per cent. What did *A* pay for the article.

(9) Equal weights of gold and silver are in value as 20 to 1; and equal volumes are in value as 1,284 to 35. A certain volume is composed of equal weights of gold and silver; find how many times more valuble the same volume would be were it composed wholly of gold.

(10) The volume of a sphere is found by multiplying the cube of the radius by 4·1888; and the area of a circle by multiplying the square of the radius by 3·1416. Find the area of a circle which by rotating about a diameter will describe a sphere whose volume is one cubic foot.

1883.

(1) Add together $\frac{3}{7}$ of £13, $\frac{1}{3}$ of $\frac{1}{2\frac{4}{5}}$ of $\frac{3}{5}$ of £2 12*s.*, and $\frac{4}{7}$ of 9*d.*

Reduce 13*s.* 4½*d.* to the decimal of 19*s.* 6*d.*

(2) Find by Practice the value of 8,596 lb. at £10 18*s.* 7½*d.* each.

(3) A person borrows $500 on April 10th, and on June 22nd pays his debt with $510.20. At what rate per cent. per annum was he charged interest?

(4) A man having a certain sum of money to invest has an opportunity of purchasing 7% stock at 95, but delays until it has risen to 110. What per cent. is his income less than if he had purchased at the first price?

(5) At an international exhibition one country was awarded 5 gold, 9 silver, and 11 bronze medals; and another 4 gold, 15 silver, and 10 bronze. Find the ratio of values for such medals that these countries may be regarded as equally fortunate.

(6) In a box there is a certain number of sovereigns, three times as many guineas, and twice as many marks (13*s.* 4*d.*) The entire amount in the is £815; how many coins of each kind are there?

(7) Find when first after 2 o'clock the hour and the minute hands of a clock make an angle of 60 degrees with each other.

(8) For each of three succeeding months the population of a North-West town rose 50%; and at the end of the third month it was 2,700. What was the population at the beginning of the time?

(9) Leap year is omitted once in every century, except those centuries whose number is divisible by 4. What is the average length of a year?

(10) A cube is formed of a certain number of pounds Avoirdupois of a substance, and the same number of pounds Troy of the same substance. What proportion will the side of this cube bear to the side of a cube formed of the same number of pounds as before, but all Avoirdupois? (175 lb. Troy = 144 lb. Avoirdupois.)

1884.

(1) Simplify $\dfrac{(4\frac{1}{5} - 3\frac{1}{6}) \times (1\frac{1}{3} - \frac{5}{6})}{(1\frac{1}{7} - 1\frac{3}{14}) \div (1\frac{2}{1} - \frac{1}{7})} \div \frac{1\frac{5}{3}}{\frac{17}{31}}$.

(2) Find the cost of ·0625 of 112 lb. of sugar, where 1 lb. costs ·0703125 of 17*s.* 9½*d.*

(3) *A* and *B* were employed to do a piece of work for \$60. They were to be paid in proportion to their ability to work, which was 4 to 5, and to the time each worked, which was 3 to 4. How much did each receive?

(4) A quantity of silk was sold at a loss of 1%; had it been sold for 4*s.* 2½*d.* per yard there would have been a gain of 1%. Find the actual selling price.

(5) A person rides to town at the rate of 8¼ mi. per hour, and after resting 35 min. walks back at the rate of 2¾ mi. per hour. The whole time occupied was 7 hr. $20\frac{5}{7}$ min. Find the distance.

(6) Instead of a yard measure a draper uses a stick which is 36·35 in. long. What does he lose per cent. by so doing?

(7) When the course of exchange between London and New York is quoted at 4·96, London exchange (*i.e.* English money) is said to be at 2% premium. From this calculate the par of exchange.

(8) If silver is worth \$1.10 per ounce, and gold \$17 per ounce, find the weight of a \$10 coin containing 37 parts in 40 of gold, and the rest silver.

(9) Equal volumes of iron and copper are found to weigh 77 oz. and 89 oz. respectively. Find the weight of 10⅓ ft. of circular copper rod, when 9 in. of iron rod of equal diameter weigh $31\frac{9}{10}$ oz.

(10) (*a*) The expense of carpeting a room 15 ft. wide was \$52.80; but if the length had been a yard less, the expense would have been \$46.20. Find length of the room.

(*b*) A rectangular solid 4½ ft. long, 3½ ft. broad, and 1⅓ ft. thick, is increased 11 in. in thickness. By how much must the breadth be diminished, so that the solid may retain the same bulk as before?

1885.

(1) Define Prime Number, Factor, Common Multiple, Discount, Exchange.

Draw a diagram showing that there must be 30¼ sq. yd. in a square rod, if the linear rod contains 5½ yd.

(2) A merchant bought 124 yd. of cloth at \$3.62½ per yard and 87½ yd. at \$4.12½ per yard. At what price per yard must he sell the whole to realize a profit of 20%?

(3) Simplify the following and give the result in £ *s.* and *d.*:

$$\tfrac{3}{5}(3\cdot\dot{3}+1\cdot25) \text{ of } £1 + \tfrac{1}{4} \text{ of } \frac{1\cdot125 - \frac{1}{3} \text{ of } 1\frac{1}{6}}{\frac{1}{10} \text{ of } 3\frac{1}{3} + \frac{1}{12}} \text{ of } 9s. + \frac{2\cdot1\dot{6}}{2\cdot0\dot{9}}d.$$

(4) A farmer sold two loads of wheat, in all 110 bush., for $94.95. One load was sold at 97c. per bushel, and the other at 72c. per bushel. How many bushels were there in each load?

(5) A merchant bought cloth at $2 per yard and sold the whole at a profit of $120; had he sold it at 20% less he would have lost $96. How many yards did he buy?

(6) What will be the cost of insuring a property worth $47,580 at the rate of $\frac{7}{8}$ of 1%, so that in case of loss the owner may recover both the value of the property and the premium paid?

(7) Divide $4,941 among *A*, *B* and *C*, so that nine months' interest on *A*'s share at $3\frac{1}{2}$% per annum, nine months' interest on *B*'s share at $3\frac{3}{4}$%, and nine months' on *C*'s share at $4\frac{1}{2}$% may all be equal.

(8) I owe a man $850 and give him my note at 90 dy.; what must be the face of the note to pay the exact sum, if discounted at $1\frac{1}{4}$% per month (bank discount)?

(9) *A* and *B* engage in trade, *A* invests $6,000 and at the end of 5 mo. withdraws a certain sum. *B* invests $4,000 and at the end of 7 mo. $6,000 more. At the end of the year *A*'s gain is $5,800 and *B*'s is $7,800. Find the amount *A* withdrew.

(10) (*a*) If a brick 8 in. long, 4 in. wide and 2 in. thick weighs 5 lb., what will be the weight of a brick of the same material 16 in. long, 8 in. wide and 4 in. thick?

(2) The top of a ladder reaches to the top of a wall when its foot is at a distance of 10 ft. from the bottom of the wall, but if the foot of the ladder be drawn 4 ft. farther from the wall the top of the ladder will reach a point 2 ft. below the top of the wall. Find the length of the ladder.

1886.

(1) *A* had $7 less than *B* had, and *B* had $10 less than *C* had. *A* gave $5 to *B* and $12 to *C*. How many dollars had *C* more than *A* then?

(2) One-quarter of the time which a man spent on a journey from M to T he travelled by steamboat at an average rate of 14 mi. per hour; $\frac{2}{3}$ of the time he travelled by railway-train at an average rate of 25 mi. per hour; and the remaining hour of the time he rode the remaining 7 mi. of his journey. Find the distance from M to T.

(3) At what time between 4 and 5 p.m. is the minute-hand exactly two minute-spaces ahead of the hour hand of a watch marking correct time?

(4) A man, assisted part of the time by a boy, completed a job in 15 hr. The man received $\frac{5}{6}$ of the pay and the boy received $\frac{1}{6}$, but the man was paid at double the rate the boy was, in proportion to the amount of work each did. How long would the man unassisted have taken to accomplish the job?

(5) How much water must be added to a mixture of 15 gal. of vinegar costing 52c. per gallon and 13 gal. costing 40c. per gallon, that \$5 may be gained by selling the whole at 15c. per quart?

(6) A total of 250 marks is to be allowed to a paper of 10 questions. To the first 7 questions the average is given. Divide the remaining marks so as to allow 7 marks to the tenth question and 5 marks to the ninth for every 3 marks allowed to the eighth.

(7) A bookseller charges on certain books 35c. on the shilling of the published price and gives a discount of 35%. What is the actual rate he charges on the shilling?

(8) A bill for \$253.03, dated 7th October, and payable at London in 3 mo. from date, was discounted in Toronto on 20th October, the discount being at the rate of 9% per annum and 45c. being charged for exchange. Find the proceeds of the bill.

(9) A cubic foot of water weighs 62·426 lb. and a gallon of water weighs 10 lb. How many gallons will a cylindrical cistern of 5 ft. diameter by 4 ft. deep hold?

1887.

(1) Prove the rule for the multiplication of two fractions.

Simplify $\dfrac{(7\frac{1}{4} - 3\frac{1}{2}) \times \{4\frac{1}{5} - (2\frac{1}{3} - 1\frac{7}{10})\}}{(7\frac{1}{4} + 3\frac{1}{2}) \div (1\frac{1}{2} - 9\frac{1}{2} \times \frac{9}{77})}$.

(2) *A*, *B*, *C*, rent a pasture for \$92; *A* puts in 6 horses for 8 wk., *B* 12 oxen for 10 wk., *C* 50 cows for 12 wk. If 5 cows are reckoned as 3 oxen, and 4 oxen as 3 horses, what shall each pay?

(3) *A* does a work in 10 dy., *B* in 9 dy., *C* in 12 dy.; all begin together, but *A* leaves in $3\frac{3}{5}$ dy. before the completion, *B* in $2\frac{3}{5}$ dy. before the completion. In what time was the work done?

(4) Prove the rule for the division of decimals. Divide to six decimal places, ·0078539 by ·9921464.

(5) On March 23rd a bank gives me \$845 for a note of \$860. When is the note due, interest 8%?

(6) Find the cost, in sterling, of 184 tons 17 cwt. 3 qr. 14 lb. of copper, invoiced to a Toronto importer at £87 17*s.* 11*d.* per ton. (Qr. = 28 lb.)

(7) I bought certain 4% stock at 75, and after a number of years sold out at 95, and found that I had made $7\frac{1}{2}$% per annum, simple interest. How long did I hold the stock?

(8) There is a mixture of vinegar and water in the proportion of 93 parts vinegar to 7 parts water; how much water must be added so that in 25 parts of the mixture there may be 2 parts water?

(9) I invested \$10,000, but sold out at 20% discount. How much must I borrow at 4% so that by investing all at 8% I may just retrieve my loss?

(10) A square field containing $27\frac{1}{2}$ ac. has a diagonal path across it. What is the length of the path in yards?

(11) When the temperature of a cube of zinc is raised from 32°F. to 212°F. each dimension is thereby increased ·3%. Find the percentage of increase in the bulk.

(12) Water is flowing at the rate of 10 mi. per hour through a pipe 14 in. in diameter, into a rectangular reservoir 187 yd. by 96 yd. In what time will the surface be raised 1 in.?

1888.

(1) Simplify (*a*) $\dfrac{\frac{3}{4}\text{ of }\frac{7}{9}\text{ of }\frac{1}{2}\frac{5}{8} - 2\frac{1}{4}\text{ of }3\frac{3}{5}\text{ of }\frac{1}{7\frac{1}{2}}}{4\frac{1}{2} - (3\frac{1}{3} + 4\frac{2}{7}) + 3\frac{7}{8} + \frac{3}{5\frac{3}{6}}}$.

(*b*) What fraction of $365\frac{1}{4}$ dy. is 349 dy. 8 hr. 52 min. $\frac{1}{2}\frac{9}{3}$ sec.?

(2) *A* can do a work in $\frac{1}{2}$ the time that *B* requires, *B* can do it in $\frac{2}{3}$ of the time that *C* takes. All working together do it in 18 dy. How long would it take each one separately?

(3) A man got a 90 days' note for \$1,360 for a lot which cost him \$1,200 cash just a year before. Money 6%; find his net gain at time of sale. (Bank discount; 360 dy. to a year; no days of grace.)

(4) Bought 78 ac. 3 rd. 15 per. 7 yd. 1 ft. 9 in. of land at \$80 per acre; sold $\frac{2}{3}$ of it at \$120 per acre, and the rest at \$·005 per square foot. Find gain.

(5) A number of men and women earned \$93 per day, each man getting \$2.25 and each woman \$1.50. Had there been 6 more men and 7 more women the whole number of women would have earned the same as the whole number of men. Find the actual number of each.

(6) A commission merchant receives 125 barrels of flour from A, 150 barrels from B, 225 barrels from C; he finds on inspection that A's is 10% better than B's, and C's is $5\frac{5}{11}$% better than A's. He sells the whole lot at \$7 per barrel, charging 4% commission. What sum must he remit to each?

(7) A compound of tin and lead weighs 10·43 times as much as an equal bulk of water, while tin weighs 7·44 times, and lead 11·35 times, as much as equal bulks of water. Find the number of pounds of each metal in 765 lb. of the compound.

(8) A bankrupt had goods worth \$7,950, which, if sold at their full value, would give his creditors $81\frac{1}{4}$% of their claims. But $\frac{3}{5}$ of them were sold at $17\frac{1}{2}$% below their value, and the remainder at $23\frac{3}{4}$% below their value. How many cents on the dollar did his creditors realize?

(9) A begins business with a capital of \$3,200; after 3 mo. B is admitted as partner with \$2,400; after 3 mo. more C is admitted with \$1,600. What fraction of the year's gain should each have?

(10) If it cost \$11.20 for paper for a room 25 ft. 3 in. long, 19 ft. 9 in. wide, and 12 ft. high, when the paper is $\frac{3}{4}$ yd. wide, find cost of the paper per linear yard. (No allowance for doors and windows.)

(11) What is the cost of polishing a cylindrical marble pillar, 2 ft. 6 in. in diameter and 12 ft. long, at \$1.25 per square foot?

(12) A square field, containing 16 ac. 401 sq. yd., has a walk around it outside 12 ft. in width. Find the area of the walk in yards.

1889.

(1) (*a*) Simplify $\dfrac{\cdot 5 \times \cdot 006}{\frac{9}{15} \text{ of } \frac{4}{5} \times (\frac{1}{4})^2} + \dfrac{\frac{1}{5} \text{ of } \frac{1}{16} \times (\frac{2}{3})^2}{1\cdot 6 \times \cdot 625}$. (Answer in fractional form.)

(*b*) Find the average, correct to four places of decimals, of $12\frac{1}{2}\frac{1}{5}$, 21, $7\frac{3}{4}$, ·034, 3·125, 0, 24·58 and $12\frac{9}{20}$.

(2) In what time will \$30,441 gain \$2,210.10 if, at the same rate, the gain on \$24,944.10 for 1 yr. and 15 dy. is \$2,596.92? What is the rate per cent. per annum (365 dy. to a year)?

(3) A house that cost \$15,500 rents for \$155 per month. It is insured for \$10,850 at $\frac{4}{5}\%$ yearly; the taxes are 15 mills on an assessment of \$12,450, and \$346.45 is spent each year on repairs. What rate of interest does the investment pay?

(4) A rectangular field, whose width is $\frac{3}{4}$ of its length, contains 15 ac. 123 per. In going from one corner to the opposite how much shorter is it to take the diagonal than to go around the two sides?

(5) A note of \$2,450, dated Halifax, June 1, 1886, for 4 mo., bearing interest at 6%, is discounted at a bank on Aug. 15th at 8%. Find the proceeds.

(6) A farm cost $3\frac{3}{4}$ times as much as a house; by selling the house at 10% *loss* and the farm at $7\frac{1}{7}\%$ *gain*, \$3,993.30 is received. Find cost of each.

(7) Bought 64 yd. of cloth at \$5.70 per yard. If it shrank 5% in length, find the selling price per yard to gain 20%.

(8) *A* and *B* are partners, *A*'s capital being $\frac{3}{5}$ of *B*'s. At the end of 5 mo. *A* withdraws $\frac{1}{4}$ of his capital, and at the end of 9 mo. *B* withdraws $\frac{1}{3}$ of his. How should they divide a gain of \$4,222.33 at the end of the year?

(9) A man sold his 5 per cents at 78 and invested the proceeds in 6 per cents at 104. His change in income being \$385, find how much 5% stock he had.

(10) A dealer shipped 400 bush. wheat at \$1.40, 800 bush. at $\$1.62\frac{1}{2}$, and 300 bush. at \$1.20, to his agent, who sold the first at 20% gain, the second at 15% gain, and the third at $4\frac{1}{6}\%$ loss. The agent's commission was 3%, and other charges were \$83.44; find the dealer's gain per cent.

(11) What is the cost of boards, at \$1 for 50 sq. ft., to make a closed box 7 ft. 10 in. long, 3 ft. 8 in. wide, 2 ft. 6 in. high (outside dimensions), the boards being 1 in. thick?

(12) Reckoning a pint to be 30 cub. in.; if 462 gal. are taken out of a cylindrical cistern 7 ft. in diameter, how many inches will the surface of the water be lowered? ($\pi = 3\frac{1}{7}$.)

1890.

(1) (*a*) Show how to find the L. C. M. of two or more numbers.
(*b*) Find the L. C. M. of 24, 105, 180, 96, 336, 84, and of
(*c*) 4410, 7350, 7875.

(2) (*a*) Prove the rule for finding the product of two fractions.
(*b*) Simplify

$$\tfrac{4}{5}(3\tfrac{1}{8} + 1\tfrac{1}{4})\,£ + \frac{1\tfrac{1}{8} - \tfrac{1}{8} \text{ of } 1\tfrac{5}{6}}{\tfrac{1}{10} \text{ of } 3\cdot\dot{3} + \tfrac{1}{7}\tfrac{3}{2}} \text{ of } \cdot 95 \text{ of } 5s. + \frac{8\cdot 4}{\cdot 012}d.$$

(3) If the Avoirdupois pound is equal to 7,000 grains Troy, and if 6,144 sovereigns weigh 133 lb. 4 oz. Troy, how many sovereigns will weigh an ounce Avoirdupois?

(4) A man engages a sufficient number of men to do a piece of work in 84 dy., if each man does an average day's work. It turns out that 3 of the men do respectively $\frac{1}{6}$, $\frac{1}{7}$, and $\frac{1}{8}$ less than an average day's work, and 2 others $\frac{1}{8}$ and $\frac{1}{10}$ more; and in order to complete the work in the 84 dy., he procures the help of 17 additional men for the 84th day. How much less or more than an average day's work on the part of these 17 men is required?

(5) How many bricks, 9 in. long, $4\frac{1}{2}$ in. broad and 4 in. thick, will be required to build a wall 45 ft. long, 17 ft. high and 4 ft. thick, supposing the mortar to increase the volume of each brick $6\frac{1}{4}\%$?

(6) A circular race-course is 22 yd. wide and has an area of 12 ac. Find the diameter of the inner circle.

(7) The area of each of the longer walls of a room is 330 sq. ft.; the area of each of the other walls is 220 sq. ft.; the area of the floor is 384 sq. ft. Allowing $\frac{1}{25}$ of area of walls for doors and windows, how many yards of paper, 18 in. wide, are required to cover the walls?

(8) The pressure of compressed air varies inversely as its volume. If the pressure on the inner surface of a cylinder fitted with a piston be 20 lb. on the square inch, and when the piston is forced in 2 in., the pressure becomes 30 lb. on the square inch; what is the length of the cylinder?

(9) A man has \$20,000 Bank Stock which is at 170 and pays a half-yearly dividend of 5%; he sells out and invests in Stocks at 108, which pays $3\frac{1}{2}\%$ half-yearly. Find the change in his half-yearly income.

(10) Bought goods at \$5.70 on 4 months' credit and sold them immediately at \$6.12 on such a term of credit as made my immediate gain $6\frac{2}{3}\%$. Reckoning interest at 4% per annum, how long credit did I give?

(11) A merchant in Montreal drew on Hamburg for 10,000 guilders at $\$\cdot 415$; how much more would he have received if he had ordered remittance through London to Montreal, exchange at Hamburg on London being $11\frac{1}{4}$ guilders for £1, and at London on Montreal $9\frac{1}{4}\%$, brokerage being $1\frac{1}{4}\%$ for remittance from London?

(12) (*a*) What is meant by averaging accounts?

(*b*) Find the equated time for the payment of the following account:—

Dr. JOHN SMITH. *Cr.*

1888			1888		
June 10	To mdse. @ 30 days	$950	July 10	By Cash - -	$450
July 15	" " 45 "	300	Aug. 15	" - -	350
Aug. 20	" " 60 "	250	Sept. 5	" - -	200
Sept. 1	" " 30 "	150			

1891.

(1) (*a*) Show that $\cdot\dot{0}4\dot{5} = \frac{5}{111}$;

(*b*) Show that $\cdot 4\dot{1}\dot{2} = \frac{68}{165}$.

(*c*) Add, without reducing to vulgar fractions, $\cdot 312$, $9\cdot 4$ and $\cdot\dot{2}3$.

(*d*) Make a drawing that will show the number of square yards in a square rod.

(2) Find the premium paid to ensure a house worth $7,500 for $\frac{3}{5}$ of its value for 3 yr., the rate being $\frac{3}{5}\%$ of the policy for each year.

(3) A tax of $24,750 is levied on a town, the assessed valuation being 1·5 mills on the dollar; what tax does a man pay on an income of $1,100, of which $400 is exempted?

(4) From the list price of a line of goods a purchaser is allowed a trade discount of 20%; a further discount of 10% off the trade price for taking a quantity, and a still further discount of 5% off his bill for cash. Find his gain per cent. by selling at 10% less than the list price.

(5) A man invest $12,000 in 3% stock at 75; he sells out at 80 and invests $\frac{1}{3}$ of the proceeds in $3\frac{1}{2}\%$ stock at 96 and the remainder at 5% par. Find the change in his income.

(6) A man puts $350 in a Saving's Bank each year, making his first deposit Dec. 31, 1890. How much will there be to his credit Jan. 1, 1895, the Bank adding 4% per annum?

(7) *A* owes *B* $400 due in 1 yr., $300 due in 2 yr., $200 due in 3 yr. What sum paid now would cancel the debt, money being worth 5% per annum compound interest?

(8) The sides of a triangle are 13, 14 and 15 ft.; find its area, and the length of the three perpendiculars from the angles on the opposite sides.

(9) The external dimensions of a rectangular covered box, made of inch stuff, are 7, 8 and 9 ft.; find the capacity of the box and the quantity of lumber in it.

(10) A well 7 ft. in diameter and 28 ft. deep is to have a lining of special bricks, fitting close together without mortar, 7 in. thick; find in tons the weight of the bricks, supposing 1 cub. in. of brick to weigh $\frac{2}{3}$ of an ounce, and 1 cwt. = 112 lb. ($\pi = \frac{22}{7}$).

(11) *A* shipped to *B* 1,000 sheep, the buying price of which was $4.50. *B* pays a freight charge of 17½c. per head and the cost of feed and yard is 2¼c. each per day. His first sale is made at the end of 2 dy. which consists of a lot of 250 head at $5.25. At the end of the third day he sells a second lot of 525 at $6, and at the same time 5 sheep are killed by an accident. The balance are disposed of at $5 per head at the end of the fifth day. *B* takes 10% of the profits for his commission and remits the balance to *A*. Make out *B*'s Account Sales to *A*.

(12) *A* has 8 bottles and *B* 2 bottles of wine. At odd times a common friend, *C*, joins them and the three share equally. To recoup *A* and *B*, *C* hands over $10. How should *A* and *B* settle between them.

(13) Add vertically and horizontally the following statement:

							T.
..	$1,169.84	$3,650.12	$189.10	$97.22	$26.55	$851.02	..
..	909.58	866.78	914.19	239.49	297.02	312.60	..
..	575.72	742.49	1,654.70	196.17	859.69	1,477.42	..
..	2,678.28	1,180.66	119.25	8,418.60	2,223.42	568.35	..
..	312.83	1,638.24	2,016.72	1,542.24	5,300.20	116.02	..
..	1,052.47	342.65	108.00	349.95	136.97	1,214.03	..
..	339.11	687.23	215.17	1,020.00	1,124.50	1,732.25	..
..	1,732.50	514.02	557.60	600.00	475.00	138.50	..
..	1,237.50	3,839.25	777.60	136.70	4,656.65	1,097.47	..
..	113.56	1,291.98	112.50	1,850.14	738.75	1,204.74	..
..	3,661.00	973.03	311.20	636.99	243.44	142.91	..
..	1,139.67	670.22	1,201.64	7,357.51	252.47	694.62	..
T.	.....	.....	.....	.....	.....	.....	..

1892.

(1) (*a*) Define and give examples of Quantity, Unit, Concrete Number, Abstract Number.

(*b*) When can concrete numbers be added, multiplied and divided?

(*c*) Explain the basis of our system of numeration.

(*d*) Show that a square number never ends in 2, 3, 7 or 8.

(2) (*a*) Find the value of

$$\frac{1}{10^2} \times \left\{ 1 - \frac{3}{1} \cdot \frac{1}{10^2} + \frac{3.4}{1.2} \cdot \frac{1}{10^4} - \frac{3.4.5}{1.2.3} \cdot \frac{1}{10^6} + \frac{3.4.5.6}{1.2.3.4} \cdot \frac{1}{10^8} \right\}$$

to 8 places of decimals.

(*b*) Express as the product of powers of prime factors:—

$$\frac{11.\ 12.\ 13.\ 14.\ 15. \ldots\ldots\ldots 38.\ 39.\ 40}{1^3.\ 2^3.\ 3_3. \ldots 8^3.\ 9^3.\ 10^3}$$

(3) A regiment of 1,000 men, 4 abreast, and marching 3 ft. apart, passes over a bridge 3 mi. 44 yd. long in 56 min. 10 sec. If each man takes 96 steps per minute, determine the length of each step.

(4) A dealer shipped 200 barrels of apples to Liverpool; the average cost of the apples was \$3.75 per barrel; for what sum must he have the apples insured at $\frac{3}{4}\%$ premium to guard against all loss, in case of shipwreck, his other expenses being \$75?

(5) *A* and *B* are two railway companies that pay respectively $4\frac{1}{2}\%$ and $1\frac{3}{8}\%$ per annum on their \$100 shares. When the price of a share in *A* is $101\frac{1}{4}$ and in *A* $32\frac{1}{4}$, what is the amount of money which, when invested in one rather than in the other, would give rise to a difference of income of \$31.50?

(6) On January 1, 1890, a person borrowed \$2,417.50 at $6\frac{3}{4}\%$ simple interest, promising to return it as soon as it amounted to \$2,582.50. On what day did the loan expire? (365 dy. = 1 yr.)

(7) Distinguish between Simple and Compound Interest, and between Interest and Discount.

A teacher's salary of \$1,000 is paid in four quarterly payments at the end of each quarter. What sum at the beginning of the year is equivalent to these payments, reckoning compound interest at 2% per quarter?

(8) A Canadian tourist goes to Paris with $5,000, which he exchanges for French money at the rate 19½c. for one *franc*. He spends 830 francs in France and thence goes to Vienna where he exchanges what he has left at the rate of 135 *florins* for 300 francs. He spends 500 florins at Vienna, and then goes to England where he exchanges his money, getting 1*s.* 8*d.* for a florin. His outlay in England is £75 10*s.* How much Canadian money has he left if £1 = $4.80?

(9) (*a*) The sides of a triangle are 25, 39, 56 ft. respectively. Find its area.

(*b*) A road runs round a circular pond; the outer circumference is 280 ft., and the inner 210 ft. Find the breadth and area of the road. ($\pi = 3{\cdot}14159$.)

(10) (*a*) The surface of a sphere is equal to ½ of that of a right circular cone; the radius of the base of the cone is 1 ft. and its height $\sqrt{3}$ ft. Find the volume of the sphere.

(*b*) Two wheels of a carriage are 3 ft. 9 in. and 4 ft. 8 in. respectively in diameter. How far will the carriage have gone when one wheel has gained 12 revolutions on the other?

ANSWERS AND SKELETON SOLUTIONS.

Exercise I. (Page 7).

(1) 161,415. (3) 132,329. (4) 98,127. (5) 4,192.
(6) 1,766. (7) 12,481,875.
(8) Total = 1,937,271; average = 193,727 nearly.
(9) 1,511,194. (10) $3,316.17.

Exercise II. (Page 8).

(1) 3,996. (2) 1,541. (3) 49·995045. (4) $5.90.
(5) $3.20. (6) Total $9,994.54. (7) $749,902.43.
(8) £9,410 1*s.* 0*d.* (9) 24,156.

Exercise III. (Page 10).

(1) 350,790. (2) 5,555,657; 3,086,521; 5,334,678,204,552.
(3) Remainder = 270. (4) 1,485. (5) $52,479\frac{171}{583}$.
(6) 60,768,396. (7) 2,231. (8) 37,217.
(9) 374; Rem. 446. (10) 27,869,764,561,775,892.

Exercise IV. (Page 11).

(1) 1,534. (2) 3,415,956. (3) 3,522,178.
(5) 121,932,631,112,635,269.
(6) 40,155,302,248,305,278,754,132.
(7) 1,630,188,053,103,649,203,285. (9) 4,222,404.
(10) 87,860,370. (11) 3,876. (12) 524.

Exercise V. (Page 12).

(14) $30,040,769,503.

Exercise VI. (Page 13).

(1) 9; $9 \times 16 \times 17$. (2) 9. (3) 1,449. (4) 12.
(5) 734,877. (7) 3. (8) $8\frac{1}{7}$. (9) $\frac{3}{280}$. (10) $4\frac{11}{120}$.

Exercise VII. (Page 14.)

(1) 882; 1,314,385,280,208. (2) $\frac{17}{88}$. (3) $\frac{8}{9} = \frac{896}{1008}$ is greatest.
(4) $\frac{5}{168}$. (5) 225. (6) $\frac{18}{143}$. (7) $\frac{6100}{10000} = .6109$.
(8) $\frac{1}{8}$. (9) $1\frac{29}{44}$. (10) $156\frac{38}{56}$.

Exercise VIII. (Page 15).

(1) 3. (2) 14,839. (3) ·0122 +. (4) $\frac{7}{11}$.
(5) 4320544·8215. (6) Europe 30·93 more. (7) $47\frac{3}{4}$ oz.
(8) 1,428 cub. ft. (9) $27\frac{3}{11}$ min. past 8 o'clock. (10) 912.

Exercise IX. (Page 16).

(1) $\frac{1}{11}$. (2) $\frac{1}{11}$; $16\frac{2}{3}\%$. (3) 10 lb. (4) 4 min.
(5) 189 coins. (6) \$1,008; \$1,071; \$42.84; \$20.16.

July, 1873 (Page 17).

(1) $4{,}261 \times$ No. $= 8{,}671$ farthings. Ans. $18\frac{3}{4}\frac{9}{8}\frac{9}{2}\frac{3}{1}$.

(2) Value $= \frac{3}{20}$ of \$20,000 = \$3,000. Ans.

(3) Public School Arithmetic, page 133.
Second part—$\frac{8}{8}\frac{5}{8} \times \frac{19}{13}\frac{9}{2}\frac{1}{4}\frac{2}{2} + 3\frac{1}{2} = 12\frac{1}{7}\frac{2}{8}\frac{7}{4} + 3\frac{1}{2} = 15\frac{5}{7}\frac{9}{8}\frac{9}{4}$.

(4) $1 \div (\frac{4}{15} + \frac{2}{9}) = 2\frac{1}{2}$ dy.

(5) $7\frac{1}{2} - 6\frac{3}{4} = \frac{3}{4}$ = increase in price of loaf. $\frac{3}{4}$ is $\frac{1}{9}$ of $6\frac{3}{4}$; price of bread is $\frac{1}{9}$ more, $\therefore$ price of wheat ought to be $\frac{1}{9}$ more: $\$1.10 \times \frac{10}{9} = \$1.22\frac{2}{9}$. Ans.

(6) $\dfrac{3{\cdot}5 - {\cdot}04}{5 - {\cdot}0625} \times \dfrac{{\cdot}035}{2{\cdot}115} = \dfrac{9688}{835425}$ Ans.

(7) Cost of 1 rod (both sides) = \$11; 1 mi. = 320 rods.
Total cost $= 11 \times 320 \times 73 =$ \$256,960. Ans.

(8) 1,760 yd. + 520 yd. + 2 ft. $\div$ 260 =
$\frac{8}{13}\frac{8}{3}$ yd. + 2 yd. + $\frac{1}{13}\frac{1}{0}$ ft. = 8 yd. + $\frac{3}{1}\frac{0}{3}\frac{1}{0}$ ft. =
8 yd. + $2\frac{4}{13}\frac{1}{0}$ ft. = 26 ft. $3\frac{5}{6}\frac{1}{5}$ in. Ans.

(9) Cost = $\$7.25 \times \frac{7}{2}\frac{2}{0}\frac{2}{0}\frac{5}{0} = \$26.19\frac{1}{16}$. Ans.

(10) $2{,}754\frac{5}{8}\frac{5}{1} + 2{,}633\frac{1}{5}\frac{9}{4} = 5{,}387\frac{67}{162}$; difference $= 120\frac{11}{18}\frac{5}{2}$.

JANUARY, 1874 (PAGE 17).

(1) Sum ÷ No. = $33\frac{1}{2}$; ∴ No. = sum ÷ $33\frac{1}{2}$.
No. = £157 12*s.* $10\frac{1}{2}$*d.* × $\frac{2}{67}$ = £4 14*s.* $1\frac{39}{67}$*d.* ANS.

(2) $\frac{3}{4}$ oz. = $\frac{1}{64 \times 20}$ bush.
No. bush. = 4,840 × $\frac{1}{4}$ × $\frac{1}{64 \times 20}$ = $29\frac{39}{128}$ bush. ANS.

(3) 102 dy., from 12 o'clock May 24th to 12 o'clock Sept. 3rd = 102 × 1,440 = 146,880 min. Subtract 150 min. to get the time to 9.30 o'clock. ANS. 146,730 min.
Second part—146,730 ÷ (365 × 1,440) = $\frac{67}{240}$ yr. ANS.

(4) $1 + \frac{5}{8} + 1\frac{1}{11} = 2\frac{63}{88}$. ANS.

(5) House + lot = house + $\frac{1}{5}$ house = $\frac{6}{5}$ house = \$3,600.
ANS. House, \$3,000; lot, \$600.

(6) 2,420 sq. yd. − $2\frac{7}{80}$ sq. yd. = $2,417\frac{73}{80}$ sq. yd. ANS.

(7) Public School Arithmetic, pages 121, 122, 125.

(8) $2 - \frac{1}{2} + 1 = 2\frac{1}{2}$. ANS.

(9) $\frac{2}{7}$ ac. yields 41 bush. ANS. $143\frac{1}{2}$ bush.

(10) $9\frac{3}{4} : 8\frac{1}{3} = 78 : 65 = 6 : 5$. The days have been shortened by $\frac{1}{6}$, hence their number must be increased by $\frac{1}{5}$ to give the same amount of work; $6 \times \frac{6}{5} = 7\frac{1}{5}$ dy. ANS.

JUNE, 1874 (PAGE 18).

(1) 1,220,230,092 − 4,800 = 1,220,225,292. If this number is divided by 6,084, we have divisor = 200,563. ANS.

(2) 1 ac. = 4,840 yd.; 1 rood = 1,210 yd.; 1 per. = $30\frac{1}{4}$ yd.; 4 sq. ft. 72 in. = $\frac{1}{2}$ sq. yd. Thus the field = 14,520 + 2,420 + $423\frac{1}{2}$ + $\frac{1}{2}$ = 17,364 × 9 × 144 sq. in. = 22,503,744 sq. in. ANS.
2nd part—3 ac. 3 roods 25 per. 3 yd. 0 ft. 108 sq. in. ANS.

(3) 797 tons 19 cwt. 2 qr. 14 lb. ÷ 5 tons 3 cwt. 2 qr. 16 lb. = 153 and the fraction $\frac{418}{583}$, or nearly 154 shares.

(4) $\frac{7}{8}$ = ·285; $\frac{5}{6}$ = ·883; $\frac{7}{8}$ = ·875, and they are in order of magnitude.

(5) $(\frac{185}{207} + \frac{2}{6}) \times \frac{5}{3} = \frac{1430}{771} = 1\frac{659}{771}$. ANS.

(6) The sums are 13,986*d.* and 4,107*d.*
(36 × 4,107) ÷ (37 × 13,986) = $\frac{2}{7}$. ANS.

(7) $\frac{1}{4}$ of $\frac{3}{8}$ capital = \$6,000; capital = \$40,000.

(8)

Sum × 43 =	£121	16*s.*	8*d.*	=	price of 43 cwt.
That sum × $\frac{1}{2}$ =	1	8	4	=	" 2 qr.
" × $\frac{1}{10}$ =		5	8	=	" 10 lb.
" × $\frac{1}{10}$ =		5	8	=	" 10 lb.
This sum × $\frac{1}{10}$ =			$6\frac{4}{5}$	=	" 1 lb.
	£123	16*s.*	$10\frac{4}{5}$	=	" whole.

(9) 5 − 2 = 3. ANS.

(10) $\frac{906}{1000}$ income = \$7,200; income = \$7,500.

DECEMBER, 1874 (PAGE 19).

(1) Product = 10,010,010 + 476 = 10,010,486, which ÷ 21,028 = $476\frac{579}{1014}$. ANS.

(2) Time = 44 sec. at 1,000 ft. per sec. ANS. 44,000 ft.

(3) 1 oz. = 480 gr.; 4,320 + 408 + 22 = 4,750 gr.
2nd part—ANS. 26 ac. 2 rd. 30 per. 8 yd. 8 ft. 115 in.

(4) Dimensions are 235 in. by 225 in. and 25 in. by 36 in.
Number yards required = (235 × 225) ÷ (25 × 36) = 58 yd. 2 ft. 3 in. ANS.

(5) $\frac{2}{5}$ sum = 13*s.* 5½*d.*; sum = £1 13*s.* $7\frac{3}{4}d.$ Fraction = $\frac{323}{576}$.

(6) $\frac{45}{8} \times \frac{3}{2} \times \frac{31}{2} \times \frac{2}{5} \times \frac{3}{2} \times \frac{37}{9} \times \frac{8}{111} \times \frac{3}{16} = \frac{2709}{64} = 42\frac{33}{64}$. ANS.

(7) Length × breadth = area; $6\frac{3}{4}$ × breadth = 46 × 9 sq. ft. ANS. $26\frac{2}{7}$ ft.

(8) 1 gal. = 8 × $\frac{1034}{3}$ cub. in.; cistern = 52 × 32 × $\frac{27}{2}$ cub in. No. gal. = (8 × $\frac{1034}{3}$ cub. in.) ÷ (52 × 32 × $\frac{27}{2}$) = 81 gal. ANS.

(9) $\frac{28}{5} + \frac{29}{18} \times \frac{27}{116} \times \frac{34}{5} \times \frac{1}{9}^2 = 5\frac{3}{5} + 3\frac{2}{5} = 9$. ANS.

(10) 2,456 links = 24·56 × 22 yd. = 540·32 yd., since 1 chain = 22 yd., 540·32 yd. at \$8.86 = \$4787·2352. ANS.

JUNE, 1875 (PAGE 20).

(1) $(1 - \frac{2}{5}) \times \frac{5}{3} = 1$. ANS.

(2) No. bbls. = 600 ÷ ¾ = 800; 4,600 ÷ 800 = \$5.75 per bbl. ANS.

(3) Price = $\frac{9}{5}$ of \$60 × 150 = \$16,200. ANS.

(4) (2*s.* $9\frac{1}{24}d.$) + (8*s.* $6\frac{5}{6}d.$) + (3*s.* $8\frac{35}{48}d.$) = 15*s.* $0\frac{29}{48}d.$ ANS.

(5) Rem. = 1,273 lb.; 1,273 ÷ $206\frac{1}{3}$ = 6 bbls. and 36 lb. ANS.

(6) He cuts 1 cord in 200 min.; 186 cords in 37,200 min.; $\frac{11}{16}$ cords in 137½ min.
No. days = 37,337½ ÷ (8 × 60) = $77\frac{551}{960}$ dy. ANS

(7) Remainder = $\frac{2}{15}$ fortune = \$8,000. ANS. \$60,000.

(8) (51,846,734 − 32) ÷ 508,301 = 102. ANS.

(9) Answer in shillings = $(49\frac{3}{11} \div 7\frac{5}{8}) \times 158\frac{1}{3}$ = £51 3*s.* $1\frac{5}{6}\frac{3}{7}\frac{3}{1}d.$ ANS.

(10) Price of rem. = \$2,896,875 − (\$56.25 × 31) = \$2,895,131.25.
Acres in rem. = \$2,895,131.25 ÷ \$20.05 = $144,395\frac{2}{4}\frac{3}{0}\frac{0}{1}$ ac.
Add $56\frac{1}{4}$ ac. sold; total = $144,451\frac{1}{1}\frac{3}{0}\frac{2}{0}\frac{1}{4}$ ac. ANS.

DECEMBER, 1875 (PAGE 20).

(1) 34.20 + 34.00 + 7.25 + 6.93 + 6.25 + 12.15 = \$100.78. ANS.

(2)

	ac.	r.	per.	
A's land =	97	2	12	
B's " =	383	0	8	= 720 ac. 3 rd. 30 per.
C's " =	240	1	10	Rem. = 600 ac. 2 rd. 1 per. ANS.

(3) $\frac{1}{2}\frac{0}{1} + \frac{2}{7}\frac{2}{1} \div \frac{1}{6}\frac{0}{3} + 5\frac{1}{4} = 5\frac{1}{2}\frac{6}{5}\frac{7}{2}$. ANS.

(4) (*a*) See Public School Arithmetic, pages 137, 138.
(*b*) Example:—$\frac{5}{11} \div \frac{4}{9}$
Let $\frac{5}{11} \div \frac{4}{9}$ = quotient required
∴ $\frac{5}{11}$ = quotient × $\frac{4}{9}$. See P. S. Arith., page 29.
∴ 5 = quotient × $\frac{4}{9}$ × 11. " " " 112.
or 5 × 9 = quotient × 4 × 11
i.e. $\frac{5 \times 9}{11 \times 4}$ = quotient = $\frac{5}{11} \times \frac{9}{4}$.

(5) $\frac{4}{5}$ remainder cost \$1,672; remainder cost \$2,090;
∴ 20 barrels cost \$110; cost per barrel = \$5.50.
Number barrels = 400. ANS.

(6) Remainder = $\frac{1}{6}\frac{3}{0}$; ∴ $\frac{7}{6}\frac{7}{0}$ sum = \$700; sum = \$6,000; and the shares are \$2,000, \$1,500, \$1,200, \$1,300. ANS.

(7) 7*s.* 6*d.* = £$\frac{7}{8}$; one guinea = £$\frac{2}{2}\frac{1}{0}$
∴ $(\frac{1}{5} \times 3\frac{3}{8}) + (\frac{3}{8} \times \frac{1}{4} \times \frac{2}{2} \times \frac{2}{2}\frac{1}{0}) = \frac{8}{4}\frac{1}{0} + \frac{6}{8}\frac{3}{0} = £\frac{2}{8}\frac{2}{0}\frac{5}{0}$.
∴ required fraction = $\frac{3}{2} \times \frac{8}{2}\frac{0}{2}\frac{0}{5} = \frac{8}{15}$. ANS.

(8) 7,494 per. cost \$370.70
∴ 11,220 per. cost 370.70 × 11,220 ÷ 7,494 = \$555.01$\frac{1}{1}\frac{5}{2}\frac{1}{4}\frac{0}{9}$. ANS.

(9) 1·3749 shillings buy 1·875 lb.

∴ 308 " " $\frac{1{\cdot}875 \times 308}{1{\cdot}3749}$ lb.

$= \frac{1875 \times 3080}{13749} = \frac{625 \times 3080}{4583} = 420\frac{1}{4}\frac{4}{6}\frac{0}{8}\frac{0}{3}$ lb. ANS.

(10) (*a*) Cost = \$1.75 × $(45 \times 11\frac{1}{4}) \div (3 \times \frac{9}{4})$ = \$131.25. ANS.
(*b*) Cost = \$1.25 × $(45 \times 11\frac{1}{4}) \div (3 \times \frac{15}{4})$ = \$56.25. ANS.

JUNE, 1876 (PAGE 21).

(1) The prices are in cents $64 \times \frac{5}{3}$, $20 \times \frac{5}{3}$, $100 \times \frac{5}{3}$, hence

$$\left.\begin{array}{l} 64 \times \frac{5}{3} \times \frac{3\,2\,0}{2} = \$20.80 \\ 20 \times \frac{5}{3} \times \frac{6\,7}{4} = \quad 5.58\frac{1}{3} \\ 100 \times \frac{5}{3} \times \frac{3\,3}{2} = \quad 27.50 \end{array}\right\} = \$53.88\tfrac{1}{3}. \quad \text{ANS.}$$

(2) $\frac{225}{8} + 18 + \frac{21}{2} = \frac{453}{3}$ shillings,

$\therefore$ fraction $= 25 \times 20 \times \frac{8}{453} = 4{,}000 \div 453 = 8{\cdot}83002 +$. ANS.

(3) 1 hhd. = 54 gal. ;
$\therefore$ 1,053 gal. are discharged in 1 hr.
and $4{,}953\frac{3}{5}$ gal. are discharged in $4{,}953\frac{3}{5} \div 1{,}053$ hr.
$= 24{,}768 \div 5{,}265 = 4$ hr. 42 min. $15\frac{5}{7}$ sec. ANS.

(4) $$\frac{16 \times 15 \times 11 \times 35}{7 \times 30 \times 11} + \frac{13 \times 9 \times 10 \times 11}{27 \times 11 \times 39 \times 5} = 40\tfrac{2}{3}. \quad \text{(A)}$$

$$\frac{11 \times 21 \times 15 \times 1}{3 \times 4 \times 2 \times 63} - \frac{2}{7} - \frac{48}{119} = \frac{55}{24} - \frac{82}{119} = \frac{4577}{24 \times 119}. \quad \text{(B)}$$

$$\text{A} \div \text{B} = \frac{362 \times 24 \times 119}{9 \times 4577} = 25\tfrac{1\,3\,4\,9}{1\,3\,7\,3\,1}. \quad \text{ANS.}$$

(5) $\$1 - {\cdot}0275 = 9725$
$[(2{,}400 \times {\cdot}9725) - 582] \div 365 = \$4.80$. ANS.

(6) 27 in. $= \frac{3}{4}$ yd.
2nd cost $= 12 \times 8 \times \frac{4}{3} \times 1.15 = 96 \times 1.53\frac{1}{3}$
1st cost $= 12 \times 8 \times 1.40 \quad = 96 \times 1.40$
Difference $= 96 \times {\cdot}13\frac{1}{3} = \$12.80$. ANS.

(7) 1 gal. = 8 pt.
$\therefore$ 162 x 8 pt. = 52 x 32 x 27 cub. in.
$\therefore$ 1 pt. $= \frac{1\,0\,4}{3} = 34\frac{2}{3}$ cub. in.

(8) A, B, C do $\frac{1}{6}$ in 1 dy. ; or $\frac{1}{3}$ in 2 dy.
$\therefore$ B, C do $\frac{2}{3}$ in the other 7 dy.
$\therefore$ B, C do $\frac{2}{21}$ in 1 dy. ; or $\frac{4}{7}$ in 6 dy. ;
$\therefore$ A did $\frac{3}{7}$ in 6 dy. ; or $\frac{1}{7}$ in 2 dy. ; 14 dy. ANS.

(9) Lot A cost $\frac{4}{5}$ of 600 ; lot B cost $\frac{4}{3}$ of 600 ;
.. total cost = \$1,280 ; loss = \$80. ANS.

(10) $3{,}655 \div 43 = 85 =$ number sold.
$680 \div 85 = \$8 =$ gain per head, $\therefore$ cost per head = \$35.
$4{,}375 \div 35 = 125 =$ total No. bought, $\therefore$ 40 head remain.
$400 \div 40 = \$10$; $\$35 + \$10 = \$45$, price at which remainder must be sold. ANS.

DECEMBER, 1876 (PAGE 22).

(1) 3 ac = 14,520 sq. yd.; 2 rd. = 2,420 sq. yd.; 27 per. = 816 sq. yd. 6 ft. 108 sq. in.
27 yd. = 27 yd.; 7 sq. ft. 23 sq. in. The sum of these is = 17,784 sq. yd. 4 ft. 131 in. = 23,048,771 sq. in. ANS.
2nd part—ANS. 18 tons 17 cwt. 3 qr. 18 lb. 11 oz.

(2) $\frac{1}{4}$ ship = \$1,260. ANS. \$5,040.

(3) (300,303,003 + 2,431) ÷ 20,306 = 14,789. ANS.

(4) $\frac{82}{81}$; $\frac{82}{10}$; 9. They are in order of magnitude.

(5) Train goes 20 yd. per minute; miles per hour = (20 × 60 × 60) ÷ 1,760 = $40\frac{10}{11}$.

(6) Length of step = (5,280 × $\frac{7}{2}$) ÷ (60 × 110) = 2 ft. $9\frac{3}{5}$ in. ANS.

(7) No. yards = ($\frac{45}{2}$ × 19 × 144) ÷ (15 × 36) = 114 yd. ANS.

(8) 83 − $4\frac{4}{5}$ + $11\frac{2}{3}$ − 7 = 76 + $6\frac{13}{15}$ = $82\frac{13}{15}$. ANS.

(9) $6{\cdot}2\dot{7}7777\dot{7} + 18{\cdot}6\dot{5}16516\dot{5} + 12{\cdot}3\dot{4}5454\dot{5} = 37{\cdot}2\dot{7}48839\dot{6}$.
$\cdot 34027 - \cdot 27777 = \cdot 0625$.

(10) Length of walls = 48 ft.; height × 48 = 60 × 9.
ANS. 11 ft. 3 in.

JULY, 1877 (PAGE 23).

(1) 5,000,000 ÷ 7,019 = 712, and remainder 2,472;
∴ to give quotient 713 and no remainder, we must add to the dividend 7,019 − 2,472 = 4,547. ANS.

(2) Expression within the brackets =

$$\frac{473}{12} \times \frac{2}{33} \times \frac{3}{43} \times \frac{4}{49} \times \frac{7}{37} \times \frac{37}{5} = \frac{2}{105}$$

$$\therefore \frac{20}{21} - \frac{2}{105} = \frac{14}{15}$$ ANS.

(3) Expression = (£$14\frac{31}{48}$ ÷ £$6\frac{23}{40}$) × (£$10\frac{13}{21}$ ÷ £$\frac{253}{480}$) =

$$£\frac{703}{48} \times \frac{30}{209} \times \frac{253}{24} \times \frac{480}{253} = \frac{575}{14} = £41\frac{1}{14} = £41\ 1s.\ 5\frac{1}{7}d.$$ ANS.

(4) 20 cwt. cost \$15; ∴ 1 cwt. cost 75c.
gain = 10c. per cwt.; 2,225 ÷ 10 = $222\frac{1}{2}$ cwt. bought. ANS.

(5) $3\frac{1}{8}$ yd. cost $\$12\frac{1}{2}$; 1 yd. cost $\frac{25}{2} \times \frac{8}{25} = \$4$.

$23\frac{7}{16}$ yd. cost $\$4 \times \frac{375}{16} = \frac{375}{4} = \$93.75$.

(6) Savings + expenditure = \$1,400
Savings + (savings + \$625.50) = 1,400
∴ 2 savings = 1,400 − 625.50 = 774.50
∴ savings = \$387.25; expenditure = 1,012.75 which ÷ 365 gives daily expenditure = $\$2.77\frac{3}{7}$. Ans.

(7) Spent $\frac{3}{10}$; $\frac{7}{10}$ left; spent $\frac{3}{5}$ of the remainder; $\frac{2}{5}$ remainder left; $\frac{2}{5}$ of $\frac{7}{10} = \frac{7}{25}$
∴ $\frac{7}{25}$ money buys $10\frac{1}{2}$ yd.; money buys $37\frac{1}{2}$ yd. Ans.

(8) Area = 5 × 6 = 30 yd.; proposed area = 6 × 7 = 42 yd.
∴ cost = $\frac{4}{3}\frac{2}{0}$ of \$25 = \$35. Ans.

(9) $18\frac{35}{297} = 18\cdot\dot{1}17845\dot{}$
$18\cdot\dot{1}17845\dot{} \times 4 = 72\cdot\dot{4}71380\dot{} =$ sum of all the numbers.

$26\cdot20\dot{7}0707\dot{}$
$3\cdot5\dot{9}25925\dot{}$
$38\cdot0\dot{6}66666\dot{}$
$67\cdot8\dot{6}63299\dot{}$ = sum of three of the numbers.

$72\cdot4\dot{7}13804\dot{}$
$67\cdot8\dot{6}63299\dot{}$
$4\cdot6\dot{0}50505\dot{} = 4\cdot60\dot{5} =$ 4th number.

(10) \$1,039.84 is discharged by \$357·445
∴ \$612.80 is discharged by $\frac{357\cdot445 \times 612.80}{1039.84} = \$210.65$. Ans.

December, 1877 (Page 24).

(1) 6 yd. 2 ft. = $6\frac{2}{3}$ yd. = 20 ft.; 25 fur. = $\frac{25}{8} \times 5{,}280$ ft.

∴ quotient = $\frac{25}{8} \times 5{,}280 \div 20 = 25 \times 33 = 825$ times.

(2) 5c. for 3 qt. = \$1.60 for 3 bush.; 10c. per gallon = \$2.40 for 3 bush.
Selling price = \$1.60 + 2.40 for 3 bush. = \$4.

(3) 1st Nr. $= \frac{55}{6}$; 1st Den. $= \frac{14}{15}$; 1st fraction $= \frac{275}{28}$.

2nd fraction $= 3$

3rd Nr. $= 1\frac{41}{60}$; 3rd Den. $= \frac{10}{63}$; 3rd fraction $= \frac{101 \times 63}{600}$.

Whole expression $= \frac{275}{28} \times 3 \times \frac{101 \times 63}{600} = 312\frac{15}{32}$.

(4) $2\frac{1}{3}$ hr. $\div$ $(3\frac{1}{8} \times 168)$ hr. $= \frac{1}{240}$.

(5) A gets $\frac{2}{5}$ sum; $\frac{3}{5}$ left; $\therefore$ B's share $= \frac{2}{3} \times \frac{3}{5} - \$20$

B gets $\frac{2}{5}$ sum $- \$20$; C's share $= \frac{3}{4} \times \frac{2}{5} = \frac{3}{10}$ sum

C gets $\frac{3}{10}$ sum

$\therefore$ sum $= \frac{11}{10} - \$20$; $\frac{1}{10}$ sum $= \$20$; sum $= \$200$.

(6) 2 ac. $= 320$ sq. rods; $320 \div 40 = 8$ rods, the width of field
$\therefore$ perimeter $= 2\,(40 + 8) = 96$ rods
number trees $= 96$ rods $\div$ 12 ft. $= 132$.

(7) 20 ac. at \$60 $= \frac{2}{5}$ cost of farm; $\therefore$ cost $= \$3{,}000$.

(8) \$1.20 per bush. $=$ 2c. per lb.; $\therefore$ 25 lb. cost 50c.
\$12.50 per M. $=$ \$1.25 per 100.
30c. per cwt. $=$ \$6 per ton.
$\$65.62\frac{1}{2} + 18.00 + 14.90 + 17.50 + 393.60 = \$509.62\frac{1}{2}$.

July, 1878 (Page 24).

(1) (*a*) See Public School Arithmetic, pages 93, 104, 96.
(*b*) $1{,}260 = 90 \times 14 = 10 \times 9 \times 7 \times 2 = 5 \times 2 \times 3 \times 3 \times 7 \times 2$
$\therefore$ the prime factors are $2^2 \times 3^2 \times 5 \times 7$.

(2) Dividend $=$ divisor $\times$ quotient $+$ remainder (A)
Divisor $+$ quotient $+$ remainder $+ 45 = 561$ (B)
Divisor $= 6 \times$ remainder; (C)
Quotient $= 6 \times$ divisor (D)
$\therefore$ quotient $= 36 \times$ remainder, from C and D.
$\therefore$ $6R + 36R + R + 45 = 561$, from B.
$\therefore$ $43R = 561 - 45 = 516$; $R = 12$
$\therefore$ divisor $= 72$; quotient $= 432$
$\therefore$ from A, dividend $= 72 \times 432 + 12 = 31{,}116$. Ans.

(3) Cost + $\frac{1}{7}$ cost = $\frac{8}{7}$ cost = \$80 ; ∴ $12\frac{1}{2}$ tons cost \$70 ;
∴ gain on $12\frac{1}{2} \times 20$ cwt. = \$10
∴ " 25×20 cwt. = \$20
∴ " 25 cwt. = \$1 ; gain on 1 cwt. = 4c. ANS.

(4) $\frac{\cdot 001 \times \cdot 001}{\cdot 0001} = \frac{1 \times 1}{100} = \cdot 01$. ANS.

(5) $\frac{2}{3} - \frac{1}{2} = \frac{1}{6}$ = amount to be run out.

$-\frac{1}{8} + \frac{1}{12} + \frac{1}{16} - \frac{1}{24} = -\frac{1}{48}$ = amount that runs out each hour when all the pipes are at work and the leak also.

$\frac{1}{6} \div \frac{1}{48} = 8$ = No. hours required to reduce to $\frac{1}{2}$ full. ANS.

(6) 10 men in 12 dy. do the whole work
10 " 4 " $\frac{1}{3}$ work ; $\frac{2}{3}$ work left.
10 " 6 " $\frac{1}{2}$ work ; $\frac{2}{3} - \frac{1}{2} = \frac{1}{6}$ work left.
3 boys in 6 " $\frac{1}{6}$ work.
1 boy in 1 dy. does $\frac{1}{6} \div 18 = \frac{1}{108}$. ANS.

(7) $\frac{2}{3}$(No. − 12) cost \$360 ; ∴ No. − 12 cost \$540
but No. " \$600
∴ 12 boxes cost \$60 ; ∴ No. = $600 \div 5 = 120$ boxes. ANS.

(8) \$9 + \$70.40 + \$64 + \$2.72 = \$146.12. ANS.

DECEMBER, 1878 (PAGE 25).

(1) See Public School Arithmetic, pages 8, 94, 104, 116, 117.
(*b*) 400,004,040,004.

(2) On hand 10,600 lb. ; sold 4,900 ; remainder 5,700
Number sacks = 5,700 ÷ 150 = 38.

(3) Number of rails = $(40 \times 16\frac{1}{2}) \div 10 \times 5 = 330$.

(4) $\frac{\text{Width} \times 20}{3 \times 2\frac{1}{2}} \times \$1.20 = \$57.60$.

∴ width = $\frac{5760 \times 3 \times 2\frac{1}{2}}{2 \times 120} = 18$ ft.

(5) Num. = $\frac{22}{7} - \frac{10}{7} = \frac{12}{7}$; Den. = $1 - \frac{3}{140} \times \frac{2}{3} = \frac{69}{70}$

Whole expression = $\frac{12}{7} \times \frac{70}{69} = 1\frac{17}{23}$.

(6) No. gal. $= \frac{4\frac{1}{8} \times 2\frac{2}{3} \times 6\frac{1}{8} \times 1728}{34\frac{2}{3} \times 8} = 49 \times 9 = 441$ gal.

(7) 12 men earn \$120 in 120 hr.
∴ 1 man earns \$10 in 120 hr.
15 men earn \$150 in 120 hr. = 15 dy. of 8 hr. each.

(8) $\frac{1}{4}$ A's share = $\frac{2}{7}$ B's; ∴ 7A's = 8B's; A's = $\frac{8}{7}$ B's.
∴ B's share + $\frac{8}{7}$ B's share = 210 ac. = $\frac{15}{7}$ B's;
or B's share = 98 ac. which cost \$1,470,
∴ B's land cost \$15 per acre; selling price = \$35 per acre.

JULY, 1879 (PAGE 26).

(1) See Public School Arithmetic, pages 8, 93, 104, 126.

(2) Fraction $= 6 \div (5 - \frac{3}{10}) = 1\frac{1}{7}$. ANS.

(3) ·101 − ·100999 = ·000001
Multiply by ·0101
Product ·0000000101. ANS.

(4) (8 × 4 × 12) cub. ft. weigh (12 × 2,000 × 16) oz.
∴ 1 cub. ft. weighs $\frac{12 \times 2000 \times 16}{8 \times 4 \times 12} = 1{,}000$ oz.

(5) 1st fraction $= \frac{1}{6}$; 2nd $= \frac{56}{13}$; 3rd $= \frac{1}{200}$ of a ton $= \frac{1}{10}$ of a cwt.
Required fraction $= \frac{1}{6} \times \frac{56}{13} \times \frac{1}{10} = \frac{14}{195}$. ANS.

(6) $\frac{60 \times 40 \times 30\frac{1}{4} \times \frac{3}{4}}{16 \times 60} \times 80\text{c.} = \$45.37\frac{1}{2}$. ANS.

(7) $\frac{1}{2}$ ac. = 80 sq. rods; 80 ÷ 10 = 8 rods = length of side
Rectangle is 10 rods by 8 rods = 165 ft. by 132 ft.
Length of walk = 177 + 177 + 132 + 132 = 618 ft.
Number bricks required = 618 × 6 × 1,728 ÷ 36 = 177,984 bricks. ANS.

(8) 40 rods = $\frac{1}{8}$ mi.; 12 sec. = $\frac{1}{300}$ hr.
∴ combined rate = $\frac{1}{8}$ mi. × 300 = $37\frac{1}{2}$ mi. per hour;
∴ rate of train = $37\frac{1}{2} - 3 = 34\frac{1}{2}$ mi. per hour. ANS.

December, 1879 (Page 26).

(1) Remainder = 684 ac. 1 rd. 32 per. 12 sq. yd.
1 share = 45 ac. 2 rd. 20 per. 25 sq. yd.

Now as the number of persons is integral we can find it by inspection, for we see that 45 is contained in 684 a little over 15 times, so that the number is probably 15 or perhaps 14. Try 15 shares thus :—

ac.	rd.	per.	yd.	
675	.	..	..	
7	2	..	..	= 30 rd.
1	3	20	..	= 300 per.
...	.	12	12	= 375 yd.
684	1	32	12	

which is the precise quantity given. Ans. 15.

N.B.—Had the remainder left after giving 12, 13, 14, or any other number shares been required, we should have subtracted the product from the amount to be divided, and thus have avoided reduction.

(2) $\frac{41\frac{1}{4} \times 24 \times 6}{27} \times 20 = \$44.$ Ans.

(3) L. C. M. of $10\frac{1}{3}$ and $11\frac{2}{3} = 105$
∴ fore wheel turns 10 times while hind turn 9 times,
i.e. one revolution more for every 10 that it makes, and it has done this 440 times
∴ distance $= 10\frac{1}{2} \times 10 \times 440 = 46{,}200$, as before.

(4) 1st Nr. $= 11\frac{1}{3} - \frac{21}{20} = \frac{617}{60}$
1st Dr. $= \frac{11}{12}(14 + \frac{5}{12} + \frac{5}{8} - \frac{7}{12} + \frac{2}{3}) = \frac{11}{12} \times 15\frac{1}{8} = \frac{11}{12} \times \frac{121}{8}$
2nd Nr. $= \frac{145}{100}$; 2nd Dr. $= \frac{1}{2}$; 2nd fraction $= \frac{8}{100}$

$$\therefore \text{expression} = \frac{617}{60} \times \frac{12}{11} \times \frac{8}{121} \times \frac{100}{9} = \frac{98720}{11979} = 8\frac{2888}{11979}.$$ Ans.

(5) $\$54.90 + \$8.92\frac{1}{2} + \$24.20 + \$6.60 + \$26.75 = \$121.37\frac{1}{2}$. Ans.

(6) 4 lb. bread cost 10c. when wheat is at 90c.; ∴ 1 lb. bread $= \frac{1}{360}$ bush. of wheat.
∴ when wheat is at 135c., 3 lb. bread cost $\frac{1}{120}$ of 135c. $= 11\frac{1}{4}$c. Ans.

(7) $\frac{4}{5}$ marked price $=$ cost $= \frac{6}{5} \times 240$
∴ marked price $= \frac{5}{4} \times \frac{6}{5} \times 240 = \$3.60$. Ans.

JUNE, 1880 (PAGE 27).

(1) The partial products are shifted to the left because the relative value of each figure of the multiplier depends on its distance from the decimal point. Thus in the multiplier 600,417 the figure 1 represents one "ten," and we really multiply by 10 units; and the 6 is really 600 thousand.

ANS. 104,803,155,405,621.

(2) See Public School Arithmetic, page 96. G. C. M. = 13.

(3) See Public School Arithmetic, page 125.
1st fraction = 2; 2nd fraction = $\frac{3}{19}$
$\therefore 2\frac{3}{19} - \frac{1}{1}\frac{2}{2}\frac{3}{3}\frac{5}{5}\frac{4}{5} = 1\frac{1}{2}\frac{6}{3}\frac{0}{4}\frac{6}{7}\frac{3}{4}\frac{4}{5}$. ANS.

(4) $(90 \times 17 \times 4 \times 1{,}728) \div (9 \times 4\frac{1}{2} \times 2\frac{1}{2}) = 104{,}448$ bricks. ANS.

(5)

		s.	*d.*
$12 \times 48 \times 63d.$	=	3,024	0
$15 \times 60 \times 6\frac{1}{4}d.$	=	468	9
$20 \times 56 \times 4\frac{3}{4}d.$	=	443	4
$14 \times 40 \times 15\frac{1}{2}d.$	=	723	4
	3 ⟌	4,659	5

N.B.—$1s. = \frac{7}{3}^{3}$c.
$3s. = 73$c.
$1d. = \frac{7}{3}^{3}_{6}$c.

$1{,}553 \times 73 = \$1{,}133.69$
$5 \times \frac{7}{3}^{3}_{6} = .10\frac{5}{3}^{5}_{6}$
$\$1{,}133.79\frac{5}{3}^{5}_{6}$. ANS.

(6) $76 \cdot 391955 \div \cdot 0000020385 =$
$763919550000 \div 920385 = 830{,}000$. ANS.

(7) Profit per dozen = $\cdot 1485 - \cdot 135 = \cdot 0135$
Total profit $\div \cdot 0135 = 79002000 \div 135 = 585{,}200$ doz. sold.
$585{,}200 \div 8{,}360 = 70$ doz. in each barrel.

(8) No. miles $= \dfrac{50 \times 32 \times 24000 \times 60}{5280 \times 70 \times 144} = 43\frac{6}{2}^{7}_{3}^{7}$ mi. ANS.

(9) $\frac{7}{1}^{6}_{0}^{6}$ longer part $= \frac{2}{1}^{2}_{5}$ shorter part;
$\therefore \frac{1}{5}$ longer $= \frac{1}{3}$ shorter; $\therefore$ longer $= \frac{5}{3}$ shorter;
$\therefore$ both $= \frac{8}{3}$ shorter $= 120$ ft. 45 ft., 75 ft. ANS.

(10) A and B do $\frac{4}{3}$ of work in 1 dy.
B " C " $\frac{1}{9}^{0}$ " "
C " A " $\frac{1}{1}^{5}_{3}$ " "

$\therefore 2$ (A, B, C) " $\frac{4}{1}^{2}_{1}^{1}_{7}$ " "
or A, B, C " $\frac{4}{2}^{2}_{3}^{1}_{4}$ " "
$\therefore$ time required $= \frac{2}{4}^{3}_{2}^{4}_{1}$ of a day. ANS.

December, 1880 (Page 28).

(1) See Public School Arithmetic, pages 7, 8. The word *Number* is used to mean a collection of units or even a single unit. See pages 9, 16.

(2)	68,590,142	85,044,059	1
4	2,774,474	16,453,917	5
1	192,927	2,581,547	13
		652,277	
2	45,935	73,496	1
1	18,374	27,561	1
2	000	9,187	1 Ans. 9,187.

(3) $17 \times 7 \times 73 = 8,687$ rations required.
48 tons = 96,000 lb.
4 cwt. = 400 lb.
2 qr. = 50 lb.
20 lb. = 20 lb.; total = 96,470 lb. 9 oz. = 1,543,529 oz.
$1,543,529 \div 8,687 = 177\frac{5}{8}\frac{3}{6}\frac{0}{8}\frac{}{7}$ oz. Ans.

(4) $1.47\frac{1}{2} + 1.18\frac{3}{4} + 4.43\frac{3}{8} + 1.89\frac{3}{8} + 4.57\frac{1}{2} = \$13.56\frac{7}{8}$. Ans.

(5) 1st Nr. $= \frac{2}{3} + 6\frac{2}{3} - 1\frac{1}{3} = 5\frac{2}{3}$.
1st Dr. $= \frac{1}{17} \times 2\frac{1}{2} \times 2$
2nd fraction $= \frac{19039}{20003}$

$$\text{Expression} = \frac{35}{6} \times 17 \times \frac{11}{45} \times \frac{19039}{20003} = 23\frac{7}{10}\frac{8}{8}\frac{3}{0}\frac{2}{1}\frac{4}{0}\frac{1}{2}.$$ Ans.

(6) Required weight $\dfrac{12\frac{1}{3} \times 6\frac{1}{2} \times 4\frac{1}{8}}{2\frac{1}{2} \times 3\frac{3}{4} \times 1\frac{1}{4}} \times 1,875 = 53,625$ lb. Ans.

(7) $\$1 - \cdot 0155 = \$\cdot 9845$.
$(\$3 \cdot 375 \times 365) + \$1230 \cdot 875 = \$2,462.75$.
And $\$2,462.75 \div \cdot 9845 = \$2501 \cdot 523 +$.

July, 1881 (Page 29).

(1) (*a*) See Public School Arithmetic, pages 16, 22, 28 and 23.
(*b*) $2,000,000,018,760,681 \div 63,245,553 = 31,622,777$. Ans.

(2) See Public School Arithmetic, page 94.
(*b*) $132,288 = 2^6 \times 3 \times 13 \times 53$
$107,328 = 2^6 \times 3 \times 13 \times 43$
$\therefore$ L. C. M. $= 2^6 \times 3 \times 13 \times 43 \times 53$
$= 107,328 \times 53 = 5,688,384$. Ans.

(3) 72,000 + 540 + 1,050 = 73,590 min. Ans.

(4) 1st fraction $= \frac{267}{117}$ = 2nd fraction.

3rd fraction $= 1{,}761\frac{4}{3}\frac{5}{2}$
4th " $= 1{,}650\frac{4}{4}\frac{3}{3}\frac{1}{2}$
Difference $= 110\frac{4}{4}\frac{6}{3}\frac{}{2} = 110\frac{2}{2}\frac{3}{1}\frac{}{6}$. Ans.

(5) Insurance, etc. - - - = \$125.00
Loss of 8c. per bush. on 2,090 bush. = 167.20
Gain to be realized on the whole = 522.50
Extra profit required on 3,135 bush. = \$814.70;
or $\cdot 25\frac{8}{6}\frac{1}{2}\frac{9}{7}$ per bushel.
∴ selling price must be \$1.05 + $\cdot 25\frac{8}{6}\frac{1}{2}\frac{9}{7}$ = \$1.30$\frac{8}{6}\frac{1}{2}\frac{9}{7}$. Ans.

(6) (*a*) $\cdot 9840018 \div \cdot 00159982$ =
98400180 ÷ 159982 = 615·070321 nearly. Ans.

(*b*) $\frac{7002450}{9999990} = \frac{285}{407}$ Ans. N.B.—G. C. M. = 24,570.

(7) 9 cub. ft. of water produce 10 cub. ft. of ice.
∴ $\frac{9}{10}$ " " " 1 " "
$\frac{9}{10}$ of 445 × 100 × 175 = 7,008,750 cub. ft. of water. Ans.

December, 1881 (Page 29).

(1) 314·159 ÷ ·0000008937
= 3141590000000 ÷ 8937; 8937 = 9 × 3 × 331
Divide by 9 and by 3 and we have left
$116355185185\cdot\dot{1}8\dot{5} \div 331 = 351526239\cdot26\frac{7}{3}\frac{}{1}$.

(2) 1st fraction $= \frac{196}{3}$; 2nd fraction $= \frac{484}{3}$; difference = 96

3rd fraction $= \frac{8}{21}$; $96 \div \frac{8}{21} = 252$. Ans.

(3) 115 at 70*d.*; 95 at 31*d.*; 84 at 43*d.*; 72 at 32*d.*; 10 at 66*d.*
= 17,571 pence; 1*d.* = $\frac{7}{6}\frac{3}{3}$c.
$17{,}571 \times \frac{7}{6}\frac{3}{3}$ = \$356.30$\frac{1}{2}$. Ans.

(4) 10 volumes of lead weigh as much as 114 volumes of water
10 " platinum " " 210 " "
∴ platinum is $\frac{210}{114} = \frac{35}{19}$ times as heavy as lead

∴ same volume of platinum weighs $56 \times \frac{35}{19} = 103\frac{3}{19}$ lb. Ans.

(5) Chain weighs $76 \times 2 = 152$ cwt. at $15\frac{1}{2}s. = 2{,}356s.$
Rope " $18 \times 6 = 108$ " $23\frac{1}{2}s. = 2{,}538s.$

Difference $= 182s. =$
£9 2*s*. Ans.

(6) Selling price $= \frac{13}{8}$ cost price $= \$2.60$; $\therefore$ cost $= \$1.60$

Required price $= 1.60 \times \frac{17}{10} = \$2.72$. Ans.

(7) Solidity of plate $= 66 \times 36 \times \frac{3}{4} = 66 \times 27$ cub. in.
" sheet = thickness $\times 54 \times 27$ cub. in.
$\therefore$ thickness $= (66 \times 27) \div (54 \times 72) = \frac{1}{4\frac{1}{4}}$ linear in. Ans.

(8) One brick and mortar $= \frac{17}{16} \times \frac{3}{4} \times \frac{3}{8} \times \frac{1}{3} = \frac{51}{512}$ cub. ft.

Solidity of wall $= 60 \times 17 \times 4$ cub. ft.
40,960 bricks. Ans.

(9) Gain $= 20\%$; *i.e.* he sells 100 lb. for cost of 120 lb.
or 10 lb. for the cost of 12 lb.
Second case:—He sells 9 lb. for the cost of 12 lb.
Second gain = 3 lb. on every 9 lb. $= \frac{1}{3} = 33\frac{1}{3}\%$. Ans.

July, 1882 (Page 30).

(1) The G. C. M. of two or more numbers is their greatest common factor. Usually the name is restricted to *integral* factors. Every measure of two or more numbers will also measure the sum or the difference of any multiples of these numbers.

4	68,590,142	85,054,059	1
4	2,734,474	16,463,917	6
7	451,550	57,073	1
10	52,043	5,030	2
1	1,743	1,544	7
1	199	151	3
	48	7	

Now 48 and 7 are prime to each other, $\therefore$ the given numbers have no G. C. M.

N.B.—We have used the combined method of multiplication and subtraction. The quotients are placed on the outside columns.

(2) Gain per M. $= 14.30 - 13.50 = .80$

$\therefore$ gain per foot $= \frac{8}{1000} = \$\frac{8}{10000}$

Total gain $= 9{,}870 \times 8 \times \frac{8}{10000} = \cdot 987 = 8 \times 8 = \$63.16\frac{4}{5}$.

(3) See Public School Arithmetic, page 121.

$N = 26\frac{9}{21} - 1\frac{3}{21} = 24\frac{17}{21} \times 63 = \frac{1512+51}{63+28} = \frac{1563}{91}$

$D = 1\frac{7}{9} - \frac{3}{5} \times \frac{35}{23} \times \frac{5}{6} \times \frac{24}{35} = 1\frac{4}{9} \times 63$

$\therefore$ Expression $= \frac{1563}{91} \times \frac{11}{2 \times 521} = \frac{33}{182}$

(4) $\frac{23}{10} \times \frac{4}{100} = \frac{92}{1000}$. Ans. $= 5462 \cdot 9911235$.

No. of Ounces $= 7{,}501\frac{1}{4} \times 16 = 120{,}020$.

(5) In $\frac{23}{6}$ min. goes 6,072 ft.
$\therefore$ " 1 " $6{,}072 \times \frac{6}{23}$ ft.
or " 1 hour goes $(6{,}072 \times \frac{6}{23} \times 60) \div 5{,}280$, miles $= 18$.

(6) $122{,}496 \times \frac{9}{12} \times \frac{9}{24} \times$ thickness $= 36 \times 16\frac{1}{2} \times 14\frac{1}{2}$

i.e. thickness $= \frac{36 \times 33 \times 29 \times 24 \times 12}{2 \times 2 \times 9 \times 9 \times 122496} = \frac{1}{4}$ ft. $= 3$ in.

(7) £1 $= 24$ francs $= \$1.14 \times 4$
$\therefore$ £250 10*s.* $= \$1.14 \times 4 \times 250\frac{1}{2}$
$= \$1.14 \times 1{,}002 = 1{,}140 + 2.28 = \$1{,}142.28$.

(8) If $\frac{1}{10}$ represents 1 mi., and $\frac{5}{10}$ represents 5 mi. = one side of square township.
$\therefore$ Number of acres $= 5^2 \times 640 = 16{,}000$.

(9) In 1 dy. 8 men + 4 boys do $\frac{1}{4} + \frac{1}{12} = \frac{1}{3}$; $\therefore$ time $= 3$ dy.

(10) In every 48 votes, 23 were for A, 25 for B.

$\therefore \left(\frac{25}{48} - \frac{23}{48}\right)$ total votes given $= 100 = \frac{1}{24}$ total votes given.

$\therefore$ total votes cast $= 2{,}400$. Ans. 300.

DECEMBER, 1882 (PAGE 31).

(1) Book work. The Public School Arithmetic does not supply the answer.

See H. Smith's Arithmetic, Canadian Edition, page 13.

(*b*) Product = 70,300,000 + 82,610 = 70,382,610.
Required factor = 70,382,610 ÷ 9,402 = $7,485\frac{1449}{1567}$.

(2) $\$5.84 + 2.32\frac{3}{4} + .93 + 2.76\frac{3}{4} + .74 = \$12.60\frac{1}{2}$.

(3) L. C. M. = L. C. M. of 22, 56, 42, 81 =
$11 \times 8 \times 7 \times 81 = 49,896$.

(*b*) $40,545 = 5 \times 9 \times 17 \times 53$; of which factors only 9 and 17 will divide 124,083, ∴ G. C. M. = 153.

(4) (*a*) Book work. See Public School Arithmetic, page 121, Exercise XLVI.

(*b*) 1st fraction = $\frac{1}{7}$; 2nd fraction = 1;
whole expression = $\frac{1}{7}$.

(5) (*a*) Book work. See Public School Arithmetic, page 157, Case II.

(*b*) 1 lb. costs 16*s.* × ·0703125
112 lb. cost 16 × 112 × ·0703125
$\frac{1}{16}$ of 112 cost 112 × ·0703125 = 7*s.* $10\frac{1}{2}d$.

(6) ANS. 7 ac. 1 rood 6 per. 21 sq. yd. 7 sq. ft. 20 sq. in.

(7) 3,750 lb. = 60,000 oz.; ∴ = 60 cub. ft.
∴ depth × $7\frac{1}{2} \times 3\frac{1}{6} = 60$; depth = $60 \div 7\frac{1}{2} \div 3\frac{1}{6} = 2$ ft. $6\frac{6}{19}$ in.

(8) 22 yd. = $\frac{1}{80}$ mi.; ∴ in 2nd case A goes $\frac{80}{80}$ while B goes $\frac{79}{80}$ mi.; ∴ in 1st case A goes $\frac{3}{4}$ of $\frac{80}{80}$ while B goes $\frac{79}{80}$.

Rates 60 : 79. ANS.

(9) A does $\frac{1}{9}$ work in 1 hr.; B does $\frac{1}{8}$; C $\frac{1}{6}$ in 1 hr.

A, B and C do $\frac{29}{72}$ work per hour. Time = $2\frac{14}{29}$ hr.

(10) $20\% = \frac{1}{5}$. Cost − $\frac{1}{5}$ cost = 60c. = $\frac{4}{5}$ cost; ∴ cost = 75c.

∴ selling price = $\frac{6}{5}$ cost = $\frac{6}{5} \times 75 = 90$c.

JUNE, 1883 (PAGE 32).

(1) (*a*) Book work.

(*b*) (Dividend − Remainder) ÷ Divisor = Quotient.

(*c*) $108,419,716,001 \div 18,748,005 = 5,783\frac{3086}{18748005}$.

(2) (*a*) Multiplicand is 349,751. "Casting out nines," rem. is 2.
Multiplier is 28,637. " " " 8.
$2 \times 8 = 16$. "Casting out nines," remainder = 7.
Product is 10,015,819,397; "casting out nines," rem. 8.
It should be 7. ∴ The product is incorrect.

(*b*) Weight = 4 lb. 2 oz. × 500,000 = 2,062,500 lb.

(*c*) $\frac{27s.\ 6d.}{4s.\ 2d.} \times 500,000 = \$3,300,000.$

(3)

	£	*s.*	*d.*	£	*s.*	*d.*
375 tons @	8	15	6 =	3,290	12	6
107½ " @	11	14	0 =	1,257	15	0
10 " @	10	10	0 =	105	0	0
17 " @	15	10	0 =	263	10	0
48 " @	18	7	6 =	882	0	0
15 " @	11	1	0 =	165	15	0

Amount of invoice £5,964 12 6 = 24⅛c. × 119,292½
= $29,027.84\frac{1}{8}$.

(4) Distance round the field = (63·5 + 27·75) × 2 = 182·5 rods.
∴ Cost = $1.75 × 182·5 = $319·375.

(5) (*a*) $\frac{362880 - 60480 + 15120 - 4392 + 1385}{362880} = \frac{314513}{362880}$.

(*b*) $= \frac{4\frac{7}{10} + 5\frac{9}{11} - 2\frac{1}{2}}{\frac{152}{11}} = \frac{8\frac{15}{55}}{\frac{152}{11}} = \frac{441}{3760}$.

(6) Gunpowder { Nitre 15 arts in 20 = ½⅝ or ¾ of powder.
Charcoal 3 " 20 = $\frac{3}{20}$ "
Sulphur 2 " 20 = $\frac{2}{20}$ or $\frac{1}{10}$ "

When 20 cwt. = charcoal, 20 cwt. × $\frac{20}{3}$ = 133⅓ cwt. is weight of powder.

Nitre = ¾ of 133⅓ = 100 cwt.
Sulphur = $\frac{1}{10}$ of 133⅓ = 13⅓ cwt.

(7) Cost of wine \$2.60 × 360 = \$ 936.00
carriage = 17.20
duties = 86.50

Total cost = \$1,039.70
gain = 50.00

Selling price = \$1,089.70

He must sell rem. which is $\frac{7}{10}$ of 360 = 306 gal. for \$1,089.70.
∴ He sells 1 gal. for \$1,089.70 ÷ 306 = \$3.56$\frac{1}{9}$.

(8) From January 3rd to April 6th = 93 dy.
Interest = 257.81 × $\frac{93}{365}$ × $\frac{8}{100}$ = \$5.25$\frac{464}{1825}$.

(9) Seconds' pendulum = 39·37079 in.
1 metre = $\frac{70}{64}$ yd. = $\frac{70}{64}$ × 36 in. = 39·375 "

Difference = ·00421 in.

(10) (*a*) Min. hand in going 12 min. gains 11 min. on hour hand
∴ as it has to gain 20 min. it must go $\frac{12}{11}$ × 20 = $21\frac{9}{11}$ min.
∴ they are coincident at $21\frac{9}{11}$ min. after 4 o'clock.

(*b*) To be at right angles there must be 15 min. spaces between minute and hour hands. As there are 20 min. spaces between them at 3 o'clock the minute hand must gain 5 min.

It gains 5 min. in $\frac{12}{11}$ × 5 = $5\frac{5}{11}$ min.
∴ $5\frac{5}{11}$ min. after 4 they are at right angles.

December, 1883 (Page 33).

(1) Indicating the work first, we have the expression
(59,404 + 47,675) (59,404 − 47,675) ÷ 7 × 13 × 19,
= (107,079 × 11,729) ÷ 7 × 13 × 19,
= (15,297 × 11,729) ÷ 13 × 19,
= 179,418,513 ÷ 13 × 19,

13 | 179,418,513,
19 | 13,801,424—1,
726,390—14,

∴ Quotient = 726,390, and remainder = 1281.

(2) Sold 5 for 11c., or 5 doz. for 132c.
Bought 5 doz. for 50c.

Gain on 5 doz. = 82c.
" 20 " = 328c.
" 11 boxes = \$36.08.

(3) Cost of fence $= \$1\frac{1}{2} \times 2(40 + 25)$
$= \$3 \times 65 = \$195$

Cost of land $\frac{40 \times 25}{160} \times \$300 = \$1{,}875$,

which is *less* than ten times the cost of the fence.

(4) If C gets 1 share, A gets 2 shares, B 2 shares $= \$70$,
$\therefore$ 5 shares $= \$70 = \$1{,}200$,
1 share $= \$1{,}270 \div 5 = \$254 =$ C's,
$\therefore$ A's share $= \$508$, and B's $= \$438$.

(5) $\dfrac{\frac{2}{5} \text{ of } 8\frac{1}{8} + 2\frac{1}{7} \text{ of } 5\frac{5}{8}}{\frac{1}{4} \text{ of } 3\frac{1}{2} - \frac{1}{2} \text{ of } \frac{1}{8} \text{ of } 2\frac{2}{3}} = \dfrac{\frac{1}{3}^{0} + \frac{2}{2}^{5}}{\frac{3}{2} - \frac{4}{9}} = \dfrac{60 + 225}{27 - 8} = \dfrac{285}{19} = 15$

(6) $\dfrac{(1{\cdot}302 + 3{\cdot}2589 + 40{\cdot}93) \times {\cdot}00297}{90{\cdot}09}$

$= 45{\cdot}4909 \times {\cdot}00297 \div 90{\cdot}09$,
$= 6{\cdot}4987 \times {\cdot}003 \div 13 = {\cdot}00149962$.

(7) Price $= \dfrac{2875 - 1083}{2000} \times 16\frac{1}{4}$

$= \dfrac{1792 \times 65}{8000} = {\cdot}224 \times 65 = \$14.56$.

(8) A must allow B a start of 1 min., *i.e.* $\frac{1}{6}$ of a mile $= 293\frac{1}{3}$ yd.

(9) Gang do $\frac{1}{8}$ of work each day; in 5 dy. $\frac{5}{8}$ work done;
$\frac{3}{8}$ work finished by 2 men in 5 dy.
$\therefore$ 1st man did $\frac{2}{3}$ work in 5 dy. ANS. $\frac{4}{15}$.

(10) Interest $= \$275.80 \times \frac{91}{365} \times \frac{7}{100} = \$4{\cdot}813$.

JUNE, 1884 (PAGE 33).

(1) See Public School Arithmetic, page 29, for the principle,
$\therefore$ 12,434 × Divisor + 2,763 = 87,911,143.
70,070. ANS.

(2) (*a*) 243 contains 27 and 81; 11 and 77 are contained in 22 and 28, these may therefore be cancelled; and we have left 7×3; $2^2 \times 7$; 2×11; 3^3; 3^4; 3^5; $3^3 \times 2^3$. Of these the L. C. M. is $7 \times 3^5 \times 2^3 \times 11 = 7 \times 243 \times 8 \times 11 = 149{,}688$. ANS.

(*b*) $94{,}605 = 5 \times 3 \times 7 \times 17 \times 53$;
$96{,}509 = 7 \times 17 \times 811$; $\therefore$ G. C. M. $= 7 \times 17 = 119$. ANS.

(3) 1 dy. $= 1{,}440$ min.; $\therefore$ 23 hr. 56 min. $= 1{,}436$ min.
Required fraction $= \frac{4}{1436} = \frac{1}{359} = {\cdot}00278565 \ldots$. ANS.

(4) (*a*) 1st fraction $= \frac{21 \times 59}{32}$; 2nd $= \frac{35}{177}$; $7\frac{7}{32}$ Ans.

(*b*) $\frac{1}{7}$.

(5) Gain per bushel $= 8\frac{1}{2}$c.;

Number bushels $= (3{,}616 - 112) \div 34 = \frac{1752}{17}$

$\frac{17}{2} \times \frac{1752}{17} = \$8.76.$

(6) (11*s*. $6\frac{1}{2}d$.) $\div 2\frac{1}{4}d. = \frac{554}{9}$ = No. square inches in surface.

$\therefore \frac{554}{9} \times \frac{1}{2} = \frac{277}{9}$ = number cubic inches in plate.

Weight of plate $= \frac{277}{1728 \times 9} \times \frac{125}{2} \times 16 = \frac{277000}{9 \times 12 \times 12 \times 12} =$ 17·73456 oz. Ans.

(7) A, B, C do 4 times the work in 48 hr.
A, B " 3 " " 48 hr.
∴ C does the work in 48 hr.
Again: A, B, C do 3 times the work in 36 hr.
A, C " 2 " " 36 hr.
∴ B does the work in 36 hr.; A in $28\frac{4}{5}$ hr.

(8) 1 in 10 = 10 in 100; 3 in 25 = 4 in 100.
Suppose 1,000 men at first; ∴ 900 after first battle and 792 after second battle are left; 3,960 ÷ 792 = 5.
Ans. 5,000 men.

(9) 16% of 1,200 = 16 × 12 = 192; net weight = 1,008 each.
1,008 × 8 × $1\frac{3}{8}$ = 1,008 × 11 = \$110.88.

(10) (*a*) 8% for 12 mo. = 32% for 48 mo. = $\frac{8}{25}$ for 16 mo.
Interest = \$24·0426.

(*b*) $3\frac{3}{4} - 3\frac{1}{2} = \frac{1}{4}$ yr. Interest for $\frac{1}{4}$ yr. = \$4.80.
∴ Interest for $3\frac{3}{4}$ yr. = 4.80 × 15 = \$72.
∴ Principal = 312 − 72 = \$240, of which interest for $\frac{1}{4}$ yr. = \$4.80; or interest on 60 for 1 yr. = 4.80;
∴ rate = 8%.

December, 1884 (Page 34).

(1) Divisor = quotient; ∴ dividend = $(\text{divisor})^2$ = 80,407,089.

(2) To leave no remainder the numbers must be 11,050 and 35,581, and of these the G. C. M. is 221.

(3) $\$34{\cdot}375 + 21{\cdot}45 + 8{\cdot}906 + 10{\cdot}453 + 9{\cdot}625 + 42 = \$126{\cdot}809$.

(4) (*a*) $5\frac{1}{2} + \frac{70}{47} + 16 = 22\frac{23}{94}$. N.B.—In the second addend, observe that by general agreement $2\frac{1}{3} \div 11\frac{3}{4} \times 7\frac{1}{2} = (2\frac{1}{3} \div 11\frac{3}{4})7\frac{1}{2}$. It would prevent all ambiguity if brackets were invariably used in such cases.

(*b*) $\frac{8}{10} \times \frac{9}{11} \times \frac{2}{100} \times \frac{456}{1000} \times \frac{17}{16} \times \frac{3}{2} = \frac{104652}{11000000} = \cdot00951381\dot{8}\dot{1}$.

(5) $\frac{\text{Width} \times 5}{\frac{3}{4}} \times 90\text{c.} = 2{,}250\text{c.}$

$\therefore$ width $= (2{,}250 \times \frac{3}{4}) \div (5 \times 9) = 3\frac{3}{4}$ yd. $= 11\frac{1}{4}$ ft.

(6) Boy does 1 piece of work in $4\frac{2}{3}$ dy.;
Man " 1 " " $\frac{3}{7}$ of $4\frac{2}{3} = 2$ dy.
Boy " 3 " " 14 dy.;
Man " 7 " " 14 dy.
Both do 10 pieces in 14 dy., or 5 pieces in 7 dy.

(7) $460 - 360 = 100$; $\frac{100}{460} = \frac{5}{23}$. The *price* per gallon has been *decreased* by $\frac{5}{23}$ of itself; therefore the *quantity* must be *increased* by $\frac{5}{18}$ of itself to preserve the *same* selling price: $\frac{5}{18}$ of $92 = 25\frac{1}{9}$ gal. See Exercise IX., page 16.

(8) 1884 was leap year; time = 423 dy.

$\$275.60 \times \frac{423}{365} \times \frac{6}{100} = \$19{\cdot}163$.

(9) The hands are 20 spaces apart; the minute hand must gain 18 and 22 spaces respectively. It gains 55 spaces every hour, or 11 spaces every 12 min., or 1 space in $1\frac{1}{11}$ min.
ANS. $4 : 19\frac{7}{11}$ min.; 4 : 24 min.

JUNE, 1885 (PAGE 35).

(1) $\cdot005904$ = five thousand nine hundred and four millionths.

(2) 1st fraction = 2; 2nd $= \frac{4}{13} \times \frac{3722}{194}$.

Result $= 2 \times \frac{13}{4} \times \frac{194}{3722} = \frac{1261}{3722}$.

(3) $17{\cdot}65\dot{4} = 17{\cdot}6545454\dot{5}$
$4{\cdot}8\dot{3}\dot{5} = 4{\cdot}8358358\dot{3}$
$6{\cdot}40\dot{8} = 6{\cdot}4088888\dot{8}$
$28{\cdot}89\dot{9}27017\dot{7}$ ANS.

(4) $2.53+2.99+9.25+27.50+21.87\frac{1}{2}+29.25=\$93.39\frac{1}{2}$. Ans.

(5) \$7.50 + .75 = \$8.25 for 100 lb., ∴ $8\frac{1}{4}$c. Ans.

(6) Interest = \$167 × 3.75 × .07 = \$43·8375.

(7) \$100 yields \$6 in 1 yr.
∴ 100 yields \$100 in $\frac{100}{6}$ yr. = $16\frac{2}{3}$ yr. Ans.

(8) Give A 2 shares, B 7 shares;
∴ \$1,200 = 9 shares, ∴ A gets \$266.66⅔; B \$933.33⅓. Ans.

(9) *First* before the minute hand passes the hour hand.

Suppose the hour hand has moved 1 space, then the minute hand has moved 12 such spaces from the figure XII. and it is still 1 such space from the figure III.

∴ 13 spaces = 15 min. on the clock
12 " = $\frac{12}{13}$ of 15 min. = 13 min. $50\frac{10}{13}$ sec. past III. Ans.

Second when the hands are together, which takes place at 16 min. $21\frac{9}{11}$ sec. past III. Ans.

(10) \$720 − sum + $7\frac{1}{2}$ sum = \$1,305
$6\frac{1}{2}$ sum = 1,305 − 720; ∴ \$90 Ans.

December, 1885 (Page 36).

(1) See Public School Arithmetic, pages 22, 93 and 94.

(*b*) 2, 3, 5, 7, 11 are the prime factors.

(2) (*a*) $\frac{1}{2}\frac{4}{3}$ Ans.

(*b*) $1,224 = 2^3 \times 9 \times 17$; $1,656 = 2^3 \times 9 \times 23$;
∴ L. C. M. $= 2^3 . 9 . 17 . 23 = 28,152$. Ans.

(3) $\frac{3}{5}$ of $\frac{5}{7}$ fortune = \$900; ∴ fortune = \$1,890.

(4) $12\frac{5}{6} \times 12 = 154$; $159\frac{1}{7} - 154 = 5\frac{1}{7}$ remainder.

(5) 1 wk. = 10,080 min.; 3·74976 ÷ 10,080 = ·000372.

(6) $\$27\frac{1}{2} \times 11\frac{3}{4} = \$323.12\frac{1}{2}$.

(7) Public School Arithmetic, pages 32, 34.

(8) Interest = $\$5\frac{1}{2} \times 8 \times 3 = \$132$.

(9) $\frac{1}{10} + \frac{1}{12} + \frac{1}{15} = \frac{1}{4}$; ∴ 4 hr.

JULY, 1886 (PAGE 36).

(1) $(88{,}176 \times 9{,}102) \div 64 = 12{,}504{,}280\frac{1}{2}$.

(*b*) $12 \times 144 \times$ number $= 827{,}658{,}432$.
No. $= 827{,}658{,}432 \div (12 \times 12 \times 12) = 478{,}969$. ANS.

(2) $\$19.38 + 5.25 + 7.35 + 6.30 + 14.00 + 16.80 = \$69.08$. ANS.

(3) $(49 + 180)\,2 \times \$1.15 = \$526.70$. ANS.

(4) (*a*) 14 price $+ 82 = 170 + 3 \times 36$
price $= (278 - 82) \div 14 = \$14$. ANS.

(*b*) $\$3{,}540 \div (69 + 37 + 12) = 30$. ANS.

(5) (*a*) Interest on \$1 for $2\frac{1}{2}$ yr. at $6\% = 15$c.
$\$300 \div .15 = \$2{,}000$. ANS.

(*b*) Interest on sum $= 2$ sum.
i.e. sum $\times$ 25 $\times$ rate $= 2$ sum;
or 25 rate $= 2$; rate $= \frac{8}{100}$; 8% ANS.

(6) A's share $=$ B's share $+ 60 = 2$C's share
$\therefore$ B's share $= 2$C's share $- 60$
C's share $=$ C's share
A's, B's and C's $= 5$C's share $- 60 = 1{,}000$
C's share $= 1{,}060 \div 5 = \$212$; B's $= \$364$; A's $= \$424$.

(7) The gang does the work in 20 dy.
i.e. $\frac{18}{20}$ work in 19 dy., leaving $\frac{1}{20}$ for the sixth man. ANS.

(8) A runs 440 yd. while B goes 420, and C 410
$\therefore$ B goes 42 while C goes 41; B gains 1 yd. in every 42 that he runs, or $10\frac{1}{2}\frac{0}{1}$ yd. in 440. ANS.

DECEMBER, 1886 (PAGE 37).

(1) $\frac{9}{52}$ ANS. 52 ANS.

(2) $\frac{1}{10000}$. ANS.

(3) Length $\times 4 = 10 \times 160$; 400 rods $= 1\frac{1}{4}$ mi.

(4) $\$12.50 \times 3 = \$37.50$. ANS.

(5) $80 + (3 \times 40) = 200$. ANS. 30 cows.

(6) 5 yr. ANS.

(7) Interest for 3 yr. = $7\frac{1}{2}$c. × 3 = $22\frac{1}{2}$c.

Int. for 219 dy. = $7\frac{1}{2}$c. × $\frac{219}{365}$ = $4\frac{1}{2}$c. Amt. $1.27. Ans.

(8) 50c. × 900 = 450; time = 150 mo. = $12\frac{1}{2}$ yr. Ans.

(9) $\frac{11}{10} \times \frac{10}{9} \times 810 = \$9.90$. Ans.

(10) A number is divisible by 9 when the sum of its digits is divisible by 9.

(11) Cow gives 25 qt. in 2 dy. = 24 oz. butter
∴ in 1 dy. 12 oz. butter. 84 lb. Ans.

(12) 1 oz. = $\frac{1}{16}$ lb., ∴ $\frac{15}{16}$ of \$64 = \$60. Ans.

July, 1887 (Page 38).

(1) 595 × 595 = 354,025. Ans.

(2) \$300. Ans.

(3) $\frac{2}{7}$ of $\frac{7}{20}$ investment = \$100; investment = \$1,000.

N.B.—This problem is not clearly expressed. The words "worth \$100 less than before" probably mean that he has \$100 less in the investment than, etc.

(4) $\frac{37}{39}$. Ans.

(5) \$685.71$\frac{3}{7}$. Ans.

(6) 12 lb. Ans.

(7) 1st farm cost \$2,500; 2nd farm cost \$3,750;
loss = \$250. Ans.

(8) On hand 12,000 rations; 2,000 consumed; 10,000 left;
$6\frac{2}{3}$ mo. Ans.

(9) Cost price = $\frac{4}{3}$ × \$24 = \$32; \$2 gain on \$32 = $6\frac{1}{4}\%$. Ans.

December, 1887 (Page 38).

(1) 5 doz. oranges + 7 doz. lemons =
100 apples + 105 apples = 205 apples.

(2) In 10 sec. boat goes 100 yd.

$\therefore$ in $5\frac{1}{2}$ dy. it goes $\frac{100 \times 5\frac{1}{2} \times 24 \times 60 \times 60}{10 \times 1760} = 2{,}700$ mi.

(3) Interest for 1 yr. = \$7.50; 146 dy. = $\frac{2}{5}$ yr.
$\therefore$ interest = $\frac{2}{5}$ of \$7.50 = \$3.

(4) For 121 repaid 100 was borrowed.
$\therefore$ " 847 " 700 "

(5) $\frac{1}{2}$ in. sq. represents 640 sq. ac.
$\therefore$ 1 " " 640 × 4 = 2,560 sq. ac.

(6) 1st charges \$2.25 for 6 hr. work.
2nd " \$2.33$\frac{1}{3}$ " "
Wages of 1st fortnight = \$27.

(7) 11 cub. ft. of ice weigh the same as 10 cub. ft. of water
$\therefore$ 11 cub. ft. of ice weigh 10,000 oz.
1 cub. ft. of ice weighs $909\frac{1}{11}$ oz.

(8) Bought 1,000 yd. at 60c.
Sold 400 yd. for the cost of 520 yd.
" 500 " " 600 "
" 100 " " 80 "
" all " " 1,200 yd. = \$720.

(9) Length of walls = 308 ft.
Cub. contents = 308 × 8 × 2 = 4,928 cub. ft.

(10) House and lot = house and $\frac{3}{4}$ house
= $\frac{7}{4}$ house = \$2,100
$\therefore$ house = \$1,200, and lot = \$900.

(11) Cistern contains 5 × 5 × 5 = 125 cub. ft.
= 125 × 1,728 cub. in.
$\therefore$ No. gal. = (125 × 1,728) ÷ 277·274 = $779\frac{1111}{1386137}$ gal.

JULY, 1888 (PAGE 39).

(1) See Public School Arithmetic, pages 137, 157, 125.

(2) \$39.75 × 486 = \$19·3185
385 × 13·5 = 51·975
\$71·2935 which ÷ ·375
gives 190·116 as the number of pounds received. ANS.

(3) $25 \times 3\frac{1}{5} = 80$ mi. 1st train was ahead.
Distance gained per hour by 2nd train was 12 mi.
$\therefore 80 \div 12 = 6\frac{2}{3}$ hr.; $6\frac{2}{3} + 4\frac{1}{5} = 10$ hr. 52 min., when
$37 \times 6\frac{2}{3} = 246\frac{2}{3}$ mi. from starting point. ANS.

(4) $\frac{3}{4}\%$ property = \$3,093.75;
$\therefore \frac{1}{4}\%$ " = 1,031.25
i. e. 100% property = $1,031.25 \times 400 =$ \$412,500. ANS.

(5) \$1.26 − \$1.05 = 21c.; 21c. − 11c. = 10c.
But gain = 11c. more than loss, $\therefore$ the 10c. must be evenly divided; $\therefore$ \$1.26 − 16c. = \$1.10 = real value of cloth.
The gain therefore = 30c.: $30 \times 800 =$ \$240. ANS.

(6) First row is double, $\therefore$ each rafter = 22 ft. 6 in.
both rafters = 45 ft. = 540 in.

$$\frac{\text{Surface of roof}}{\text{Surface of a shingle}} = (540 \times 54 \times 12) \div (4 \times 6) = 14{,}580 \text{ shingles.}$$

(7) Average daily pay = 92c.
Boys get 65c.; men 110c.
$\therefore$ 2 boys + 3 men give 92c. average daily wage;
for 92 − 65 = 27, and 110 − 92 = 18. But 18 : 27 as 2 : 3
hence 8 boys + 12 men will give the average. ANS. 12.

(8) Area = 432 per.: sides are as 4 : 3; or 1 : $\frac{3}{4}$

$\therefore \frac{3}{4}$ of 432 = 324 sq. per. in the square on the least side.

hence side = $\sqrt{324} = 18$. Greatest side = 24.

(9) $\frac{115}{100}$ of \$9,000 = $\frac{80}{100}$ of No. 2's capital

i.e. \$10,350 = $\frac{4}{5}$ capital, $\therefore$ capital = \$12,937.50.

DECEMBER, 1888 (PAGE 40).

(2) \$8.00 − .80 = \$7.20; \$2.80 ANS.

(3) 27 men = 81 boys; \$82.60 ÷ 118;
boy gets 70c., man \$2.10. ANS.

(4) $\$387.56 \times \frac{246}{365} \times \frac{6}{100} =$ \$15.68. ANS.

(5) \$20 − \$15 = \$5 gain on \$15; $33\frac{1}{3}\%$ ANS.

(6) $(62,832 - 4,800) \times 8 \div 128 = 3,627$ cords.

(7) $870 \times 4\frac{1}{2} \times R = 274.05$

$\therefore R = 274.05 \times \frac{2}{9} \div 870 = \frac{7}{100}$; rate = 7%

Interest on \$1,000 for $\frac{1}{4}$ yr. at 7% = \$17.50;
Amount = \$1,017.50 ANS.

(8) 9 rods × 11 rods = $148\frac{1}{2}$ ft. × $181\frac{1}{2}$ ft. = size of lot
$\therefore$ length of sidewalk = $(160\frac{1}{2} + 185\frac{1}{2}) \times 2$
$\therefore$ area in yards = $346 \times 8 \div 9 = 307\frac{5}{9}$ sq. yd. ANS.

JULY, 1889 (PAGE 41).

(1) 60 lb. wheat = 40 lb. flour
$\therefore$ No. barrels flour = $343 \times 40 \div 196 = 70$ barrels. ANS.

(2) 5 mo. 12 dy. = $5\frac{2}{5}$ mo. = $\frac{9}{20}$ yr.

Interest = \$597.50 × $\frac{49}{20} \times \frac{8}{100}$ = \$117.11. ANS.

(3) In 7 hr. A will be 7 mi. ahead; of this 7 mi. A will walk 4 and B 3; 24 mi. ANS.

(4) Diameter × $\frac{22}{7} \times 360 = 1$ mi. = 5,280 ft.

Diameter = $5,280 \times \frac{7}{22} \div 360 = 4$ ft. 8 in. ANS.

(5) $10\% = \frac{1}{10}$; $\therefore$ at the end of each year population becomes $\frac{11}{10}$ of what it was at first; $\therefore$ final population =

$10,000 \times \frac{11}{10} \times \frac{11}{10} \times \frac{11}{10} = 13,310$. ANS.

(6) 1 linear inch = 8 mi.; $\therefore$ 1 sq. in. = 64 sq. mi.

$\therefore 1\frac{5}{16} \times 1\frac{1}{8}$ sq. in. = $\frac{21}{16} \times \frac{9}{8} \times 64 \times 640$ ac. = 60,480 ac. ANS.

(7) \$7 pays for \$35 for 40 mo.

$\therefore \frac{1}{200}$ pays for \$1 for 1 mo.; $\therefore$ rate = $8,750 \div 200 = \$43.75$. ANS.

(8) $\frac{1}{4}$ mi. = 1,320 ft.;

$\therefore$ planks = $1,320 \times 8 \times 2 = 21,120$;
Scantling = $1,320 \times 4 = 5,280$ = 26,400 ft. of lumber

$26{\cdot}4 \times 17 = \$448.80$. Ans.

(9) \$1,171.41. Ans.

December, 1889 (Page 42).

(1) $(\$82.80 - \$72) \div 12c. = 90$; $\$72 \div 90 = 80c$. Ans.

(2) Time = 567 dy.

$\therefore$ Interest = $\$84.25 \times \frac{567}{365} \times \frac{7}{100} = \$9.17$ nearly. Ans.

(3) One pint reaches 3,000 in. = 250 ft.; 1,147 pints reach, etc., 54 mi. 543 yd. 1 ft. Ans.

(4) The question should have stated whether the ditch lies *inside* or *outside* of the orchard. We take it *outside*.
$\therefore$ $24\frac{2}{3}$ rods by $15\frac{1}{4}$ rods = 407 ft. by $251\frac{5}{8}$ ft.;
$\therefore$ length of ditch = $407 + 407 + 251\frac{5}{8} + 251\frac{5}{8} + 7\frac{1}{2} + 7\frac{1}{2} = 1,332\frac{1}{4}$ ft.
Price = $1,332\frac{1}{4} \times 3\frac{3}{4} \times 4 \times 1\frac{3}{4} = \$349.71\frac{9}{16}$. Ans.

(5) $12\frac{1}{2}\% = \frac{1}{8}$; $15\% = \frac{3}{20}$; $\therefore \frac{9}{8} \times \frac{17}{20}$ cost = \$306; \$320 Ans.

(6) 12 ft. 3 in. − 9 in. = $11\frac{1}{2}$ ft. = height of paper.
Area of ceiling = $26\frac{1}{2} \times 16\frac{2}{3}$ = $441\frac{2}{3}$ sq. ft.
" walls = $86\frac{1}{3} \times 11\frac{1}{2}$ = $992\frac{5}{6}$ "
$1,434\frac{1}{2}$
Doors and windows = $98\frac{1}{2}$
Amount to be papered = 1,336 sq. ft.

$1,336 \div \left(\frac{21}{8} \times 3\right) = 169\frac{4}{63}$ ft., or 56 yd. 1 ft. $7\frac{4}{63}$ in. Ans.

(7) \$16 per ton = 8 mills per lb.; price of hay = \$24.12
Price of groceries =
$\$4.80 + 5.85 + 2.75 + 6.15 + 2.37 = \$21.92$
Balance in cash = \$2.20. Ans.

(8) $\frac{7}{26}$ mill cost \$4,064.55 ; $\therefore$ mill cost $\frac{26}{7}$ of \$4,064.55.

At $\frac{1}{20}$ more cost Smith pays

$\frac{9}{35} \times \frac{21}{20} \times \frac{26}{7}$ of \$4,064.55 $= 27 \times 13 \times \$11{\cdot}613 = \$4{,}076{\cdot}163$. Ans.

(*b*) $\frac{7}{26} + \frac{9}{35} = \frac{479}{310}$; $\therefore$ remainder $= \frac{431}{910}$.

(9) $24\frac{1}{5}$ sq. yd. $= (24{\cdot}2 \div 4840)$ sq. ac. $= \frac{1}{200}$

76 sq. rods $= (76 \div 160)$ " $\frac{95}{200} = {\cdot}48$ ac

Farm $= 184{\cdot}48$ ac.
$3{\cdot}85 + 9{\cdot}147 + 76{\cdot}9 + 23{\cdot}608 + 34 = 147{\cdot}505$ ac.
Uncleared part $= 184{\cdot}48 - 147{\cdot}505 = 36{\cdot}975$ ac.
$\therefore$ % uncleared $= 3697{\cdot}5 \div 184{\cdot}48 = 20{\cdot}0428 +$. Ans.

(10) \$2,648.78. Ans.

July, 1890 (Page 43).

(1) \$2,213.47.

(2) Father's age = 5 times boy's age = 3 (boy's age + 6)
2 times boy's age = 18. Ans. 9 yr. old.

(3) $(200 \times 20 \times 33) \div 27 = 4{,}888\frac{8}{9}$ cub. yd. Ans.

(4) 12 men = 72 boys; 16 women = 48 boys; whole = 150 boys
$\therefore$ 1 boy gets \$2.20; each woman \$3.60; each man \$13.20. Ans.

(5) Total tax = 7 mills $\times$ 9,600 = \$67.20.

(6) Time = 671 dy., 1892 being leap year

Interest $= \frac{33}{2} \times \frac{13}{200} \times \frac{671}{365} = \$1{\cdot}9716$, say \$1.98

Amount = \$16.50 + 1.98 = \$18.48. Ans.

(7) 15 drains, 80 rods long, at 33c. per rod
30 ac., 2 bush. per acre, at 66c. per bushel
$(15 \times 80 \times 33) \div (30 \times 2 \times 66) = 10$ yr. Ans.

(8) 18 men do the work in 450 hr.
3 " " (450×6) hr.
15 " " $(450 \div 5) \times 6 = 60$ dy. of 9 hr. Ans.

Otherwise:—$\frac{1}{6}$ *less* men require $\frac{1}{5}$ *more* time, or 540 hr.
$= 60$ dy. of 9 hr. each.

(9) Distance = 5 mi.; difference of rates = 1 mi. per hour
$\therefore$ time = 5 hr.; A goes 20 mi. Ans.

December, 1890 (Page 45).

(1) \$2,495.08.

(2) At \$60 we get $\frac{5}{6}$ ac. for \$50 = final remainder
$= \frac{1}{6}$ of 3rd rem., $\therefore$ 3rd rem. = 5 ac. $= \frac{1}{5}$ 2nd remainder
$\therefore$ 2nd remainder = 25 ac. $= \frac{1}{4}$ of original; 100 ac. Ans.

(3) $1\frac{1}{2}$c. per pound on 600 lb. = 675c. = profit
5,210c. = cost price
600 − 65 = 535 lb. sold for 5,885c. 11c. Ans.

(4) When A starts B is $37\frac{1}{2}$ mi. distant; they approach at 6 mi. per hour, and meet in $6\frac{1}{4}$ hr. B takes 15 hr. to reach K, or $8\frac{3}{4}$ hr. after meeting A, *i.e.* he goes $8\frac{3}{4} \times 2\frac{1}{2} = 21\frac{7}{8}$ mi.

Secondly:—A takes $12\frac{6}{7}$ hr. to reach Belleville; hence B has $15 - 12\frac{6}{7}$ hr. to walk, or $2\frac{1}{7} \times 2\frac{1}{2}$ mi. $= 5\frac{5}{14}$ mi.

(5) Time = 365 + 318 = 683 dy.

Interest = $\$162.50 \times \frac{683}{365} \times \frac{11}{200} = \$16{\cdot}7241$, say \$16.73

Amount = \$162.50 + 16.73 = \$179.23. Ans.

(6) L. C. M. of $\frac{3}{4}$, $\frac{4}{4}$, $\frac{5}{4}$ yd. is 15 yd.

$\therefore$ cost $= 20 \times 15 \times \frac{4}{3} \times \$1.10 = \$440$. Ans.

(7) 108 ac. at ($12.50 + $14.75) = $2,943.00
(180 + 96) ½ rods at $1.35 = 745.20
$3,688.20
Deduct $1,160 + $17.20 = 1,177.20
Net cost = $2,511.00
Cost per acre = $2,511 ÷ 108 = $23.25. ANS.

(8) $120 × $\frac{5}{3}$ × rate per $ = $\$\frac{41}{4}$.
Rate per cent. = $\frac{41}{4} \times \frac{3}{5} \times \frac{1}{120} \times 100 = 5\frac{1}{8}\%$. ANS.

(9) $20\% = \frac{1}{5}$, ∴ cost = $\frac{5}{6}$ selling price; $\frac{1}{5}$ cost = $\frac{1}{6}$ selling.
Farmer's gain = 5 bush. at 90c. = $4.50
$25\% = \frac{1}{4}$, ∴ merchant's gain = $\frac{1}{5}$ of selling price.
= $\frac{1}{5}$ of $25 = $5; merchant's advantage = 50c. ANS.

JULY, 1891 (PAGE 46).

(1) $2,543.22.

(2) Time = 438 dy.
Interest = $360 \times \frac{438}{365} \times \frac{15}{200} = \frac{3240}{100}$ = $32.40; $392.40 ANS.

(3) He pays $20 for 144,
He gets $20 for 100; gain = 44%.

(4) $\frac{3}{8}$ ac. + $\frac{1}{4}$ ac. + $\frac{1}{4}$ ac. = $\frac{7}{8}$ ac. ANS.

(5) ·065 + ·105 + ·27 = ·44; ·56 left; $\frac{1}{4}$ of ·56 = ·14 = 280 sheep;
∴ ·01 = 20 sheep; whole flock = 2,000 sheep. ANS.

(6) $\frac{5}{19}$ of $9,500 = $2,500 = A's share; $7,000 left.
If B gets 3 shares, C gets 4 shares = 7 shares
∴ 1 share = $1,000; B gets $3,000, C $4,000. ANS.

(7) $\$113.75 \div .65 = 175$ lb. = weight of A + P
25 lb. = " A − B

200 lb. = weight of 2A
A, 100 lb.; B, 75 lb. Ans.

(8) $16 \times 10 \times 2 \times 20c. = \$64.00$
$16 \times 10 \times 10c. = 16.00 = \$80.$ Ans.

(9) $\$12.60 + \$18.00 + \$11.00 + \$8.75 + \$4.90 = \$55.25$
Account = 54.45

Balance due farmer = .80c.

July, 1892 (Page 47).

(1) $\$3.00 + 14.25 + 5.17\frac{1}{2} + 1.46\frac{1}{4} + 1.56\frac{1}{4} + 1.87\frac{1}{2} + 4.05 + .52$
$= \$31.89\frac{1}{2}$.

(2) (*a*) $11 \times 3\frac{3}{3} \times 3$ for \$3 = 110 ft. for \$3

$\therefore$ 128 ft. cost $\frac{300}{110} \times 128 = \$3.49\frac{1}{11}$. Ans.

(*b*) $\frac{110}{128} \times 400 = \$3.43\frac{3}{4}$ per cord. Ans.

(3) Dimensions: 12 yd., 11 yd. and 6 yd.
Outside area $= 46 \times 6 = 276$ sq. yd.
Floors $= 11 \times 10 \times 2 = 220$

496 sq. yd. at 10c. = \$49.60.

(4) Time = 146 dy.

Interest $= \$80 \times \frac{146}{365} \times \frac{21}{400} = \$1.68.$

Amount $= 80 + 1.68 = \$81.68$. Ans.

(5) L. C. M. of $\frac{1}{4}, \frac{1}{2}, \frac{3}{4}$, 3, 5, 7, 35, 140 = 420

\$420 + \$15 = \$435. Ans.

(6) 1 year's wages = 10 sheep + \$160
7 " = 70 " + \$1,120 (A)
But 7 months' wages = 10 sheep + \$60
$\therefore$ 7 years' " = 120 " + \$720 (B)
$\therefore$ 70 sheep + \$1,120 = 120 sheep + \$720
\$400 = 50 sheep; $\therefore$ 1 sheep = \$8. Ans.

(7) $69 \cdot 166\frac{2}{3} + 8 \cdot 2 + 5 \cdot 445 + \cdot 065 + 20 \cdot 083\frac{1}{3} = 102 \cdot 96$
$6 \cdot 05 \times 17 = 102 \cdot 85$
Remainder $= \cdot 11$. ANS.

(8) $\frac{23}{400}$ amount $= \$21.16$

Amount $= \$21.16 \times \frac{400}{23} = \$368$. ANS.

(9) (*a*) \$150,000 assessment pays \$1,800 taxes
\$1,500 " " \$18 "
\$4,500 " " \$54 "
(*b*) \$150,000 " " \$300 per annum
\$1 " " $\$\frac{1}{500}$ " $= 2$ mills. ANS.

PUBLIC SCHOOL LEAVING, 1892 (PAGE 48).

(1) (*a*) See Public School Arithmetic, page 93.
(*b*) $13,230 = 2 \times 3^3 \times 5 \times 7^2$
$22,050 = 2 \times 3^2 \times 5^2 \times 7^2$
$23,625 = 3^3 \times 5^3 \times 7$.
(*c*) G. C. M. $= 3^2 \times 5 \times 7 = 315$.
L. C. M. $= 2 \times 3^3 \times 5^3 \times 7^2 = 330,750$.

(2) 1st income $= 8,940 \times \frac{9}{200} = \$402.30$

2nd income $= 8,940 \times \frac{102\frac{3}{8}}{74\frac{3}{8}} \times \frac{3}{100} = \$369.16\frac{16}{17}$

Annual loss $= \$33.13\frac{1}{17}$

(3) Amount due on July 3rd = \$2,400 + \$60 interest = \$2,460.00
Int. from May 22nd to July 6th at 7% (45 dy.) = 20.66
Net proceeds = \$2,439.34

(4) $\frac{5}{4}$ cost of first $= \frac{3}{4}$ cost of second

$\therefore$ 5 cost of first = 3 cost of second
Let $15x$ = selling price of each
$\therefore$ A cost $12x$ and B cost $20x$
Cost of both $= 32x$; both sold for $30x$
Loss $= 2x = \$9.60$
$\therefore 12x = \$57.60$ = cost of A
$20x = \$96.00$ = " B. ANS.

(5) $2\frac{1}{2}\%$ commission on \$27,500 = \$687.50
Freight and storage, = 250.00

\$937.50

\$27,500 − \$937.50 = \$26,562.50 to be spent in pork.
\$6.25 + $2\frac{1}{2}\%$ = \$6.25 + ·15625 = \$6·40625 cost of 1 cwt.
\$26,562.50 ÷ \$6·40625 = 4,146$\frac{14}{41}$ cwt. pork purchased. Ans.

$2\frac{1}{2}\% = \frac{1}{40}$; $\therefore \frac{41}{40}$ of the cost is the total cost of pork

$\therefore$ commission $= \frac{1}{41}$ of money spent

2nd commission $= \frac{1}{41}$ of \$26,562.50 = \$647.87

1st commission = 687.50

Whole commission = \$1,335.37

The account sales stands thus:—
Cr. by wheat \$27,500
Dr. to 4,146$\frac{3}{5}\frac{1}{2}\frac{3}{5}$ cwt. pork at \$6.25 = \$25,914.63
" storage and freight = 250.00
" commission on sale and purchase = 1,335.37

\$27,500.00

(6) 5 mi. of fence will require:—
3,302 posts at 12½c. = \$412.75
35,200 ft. lumber at \$14 = 492.80
30 mi. wire at \$12.80 = 384.00

Total cost = \$1,289.55 Ans.

(7) (*a*) 1 gal. = 160 oz.;

$\therefore$ 1 gal. occupies $160 \div 1{,}000 = \frac{16}{100}$ cub. ft.

No. gallons in cisetrn $= 4 \times 4 \times \frac{22}{7} \times 6 \times \frac{100}{16} = 1{,}885\frac{5}{7}$ gal.

(*b*) The volume of the sphere $= \frac{4}{3} \times \frac{22}{7} \times 8$

$\therefore 4 \times 4 \times \frac{22}{7} \times$ height $= \frac{4}{3} \times \frac{22}{7} \times 8$; $\therefore$ height = $1\frac{1}{3}$ ft.

(8) \$64,277.50.

ALGOMA AND PARRY SOUND (PAGE 49).

(2) (*a*) $\frac{11}{39} - \frac{2}{21} + 18\frac{8}{91}\frac{8}{91} = 18\frac{2}{13}$

(*b*) $7\frac{9}{32} + 7\frac{3}{8} + 6\frac{7}{64} + 7\frac{9}{44} = 27\frac{49}{64} + \frac{19}{44}$

Sum of remaining fractions $= 52\frac{1}{48} + \frac{19}{44}$

Difference $= -24\frac{49}{1152}$.

(3) (10 yd. at $\frac{20}{3}$c.) + (1 yd. at 8c.) = $\frac{224}{3}$c.

11 yd. at $\frac{28}{3}$c. = $\frac{308}{3}$c.; gain = 28c. on 11 yd. ANS. 44 yd.

(4) In 300 dy., A and B do 15 pieces of work, B and C 12, A and C 10;

∴ C does 7 pieces in 600 dy., and B 17 pieces, and A and B 30.

Hence A and B do $\frac{15}{60}$ in 5 dy., C $\frac{14}{60}$ in 20 dy., and B will do the $\frac{31}{60}$ in $18\frac{4}{17}$ dy.

(5) $\left(\frac{3}{4}\text{ No.} + 14\right)\frac{4}{5} + 8 = \text{No.}$; No. = \$48.

(6) Cost price = $58\frac{1}{3}$c.; at the given prices there will be a *gain* of $28\frac{1}{3}$c. and $18\frac{1}{3}$c. on the first two; and a *loss* of $21\frac{2}{3}$c. and 25c. on the other two; these are equal.

ANS. 20 lb. of each kind.

(7) 1st income = $\frac{3}{44}$ sum invested; 2nd = $\frac{11}{44}$ sum invested in 1st, ∴ $\frac{14}{44}$ sum = 1,400. ANS. \$4,400, \$17,600.

(8) True discount = $\frac{1}{11}$; bank discount = $\frac{1}{10}$

1st + 2nd = 400; $\frac{1}{10}$ 1st + $\frac{1}{11}$ 2nd = 38; \$180 ANS.

(9) Down rate = 12, up rate = 4, *i.e.* 3 : 1 is the ratio of the rates; ∴ 1 : 3 is the ratio of the times; 2 hr. going down, 6 hr. going up. ANS. 24 mi.

(10) 1 gal. = 10 lb. = 160 oz. = $\frac{6}{100}$ cub. ft.

$\therefore 71\frac{5}{63}$ gal. = $\frac{4525}{63} \times \frac{16}{100} = \frac{724}{63}$ cub. ft.

Cylinder = $\frac{22}{7} \times 8^2 \times 30 \times \frac{1}{1728} = \frac{220}{63}$ cub. ft.

Cube = $\frac{724}{63} - \frac{220}{63} = 8$ cub. ft.; $\therefore$ side = 2 ft.

Paper A (Page 50).

(1) $\frac{2}{5}$ horse = \$50, etc. Ans. \$250.

(2) If the lots had been equal in number the average price would have been \$5; as it was the cost was \$20 more than this average, therefore the selling price was \$30 + 20 = 50 over this average, *i.e.* \$½ on the average gave \$50; number sheep = 100.

(3) Add the two lots and 11 wheat + 11 oats = \$16.94,
$\therefore$ 11 bush. oats = \$3.74, or 1 bush. = 34c.
Subtract the prices, difference = 86c.,
which = 1 bush. wheat − 1 bush. oats;
$\therefore$ first lot contains 6 of wheat and 5 of oats.

(4) Ans. $\frac{27}{56}$ dy.

(5) $\frac{3}{4}$ A's money gives \$800 interest in 6 yr. at 5%;
A's = \$3,555$\frac{5}{9}$, B's = \$5,925$\frac{5}{7}$.

(6) Shares have 2, 4, and 5½ yr. to run:
Interest on \$1 for these periods = $\frac{12}{100}, \frac{24}{100}, \frac{33}{100}$;
Discounts = $\frac{12}{112}, \frac{24}{124}, \frac{33}{133}$;
Present worths = $\frac{100}{112}, \frac{100}{124}, \frac{100}{133}$, and these are the proportions of the cash values of the respective shares;
$\therefore 100\left(\frac{1}{112} + \frac{1}{124} + \frac{1}{133}\right) = \$3{,}000.$
The shares are \$1,092.76, \$987.01, and \$920.23.

(7) The 5% loan + the 6% loan = \$98; also

$\frac{3}{4}$ (") + $\frac{9}{10}$ (") = \$81. × through by $\frac{4}{3}$ and

$\therefore$ (") + $\frac{3}{5}$ (") = \$108.

$\therefore \frac{1}{5}$ (") = \$10. Ans. \$50, \$48.

(8) $3\frac{7}{11}\% = \frac{2}{55}$, $\therefore$ \$1 cost is intended to produce $\frac{57}{55}$ sales.

$\therefore$ for every $\frac{3}{5}$ yd. bought he got $\frac{57}{55} \times \frac{3}{5} = \frac{171}{275}$ cost of 1 yd.

and for every $\frac{2}{5}$ yd. bot. he got $\frac{2}{5}\left(\frac{57}{55} - 2c.\right) = \frac{114}{275}$ cost 1 yd. $-\frac{4}{5}$c.

$\therefore$ for every 1 yd. bought he got $\frac{285}{275}$ cost of 1 yd. $-\frac{4}{5}$c.

Actual gain on 1 yd. = $\frac{10}{275}$ cost of 1 yd. $-\frac{4}{5}$c. = $\frac{11}{15}$ of proposed gain

$\therefore \frac{2}{55}$ cost per yard $-\frac{4}{5}$c. = $\frac{11}{15}$ of $\frac{2}{55}$ cost per yard.

$\therefore \frac{4}{15}$ of $\frac{2}{55}$ cost = $\frac{4}{5}$c.; cost = 82½c. per yard.

(9) A, B and C do respectively $\frac{1}{18}$, $\frac{1}{30}$, $\frac{1}{33}$ per day; $\therefore$ let 4,950 shares = whole work; average for 25 dy. = 198 shares per day. A does 77 shares *above*, B 33 *below*, and C 48 *below* the average each day. Now A must make up for the deficiency of B and C; hence as in alligation we must find some multiple of 77 = the sum of some multiples of 33 and 48. We may take A 63, B 35, C 77 days respectively, as one solution out of many possible ones; so that if the work lasted 175 dy., A would do (63 × 77) shares *over* the average, and B and C together would do (35 × 33) + (77 × 48) *under* the average. Hence when the work lasts only 25 dy., A must work $\frac{1}{7}$ of 63, B $\frac{1}{7}$ of 35, C $\frac{1}{7}$ of 77 dy. Hence one set of answers is 9, 5, 11 dy. The wording of the question might have been made more precise.

(10) Let x be the yearly instalment, then at the end of the period we have the equation

$x(1 + 1.05 + 1.05^2 + \text{etc.} + 1.05^8 + 1.05^9) = 1{,}500 \times 1.05^{10}$;
or $x \times 12{\cdot}57766 = 1{,}500 \times 1{\cdot}628835$. Ans. \$194·2569 + .

N.B.—In performing the work, carry out 1.05^2, 1.05^3, etc., 1.05^{10} first and check the products to detect any error, next add the proper quantities, and lastly divide out.

Paper B (Page 51).

(2) \$1,400.

(3) $\sqrt{(40^2 + 30^2)} = 50$ mi. Euc. I., 47.

(4) Area of base $= 20^2 \times {\cdot}7854$;
Content $= 314{\cdot}16 \times 9 = 2827{\cdot}44$ cub. ft.

(5) Bank discount on \$1 $= {\cdot}09 \times \frac{63}{360} = \${\cdot}01575$;

$\therefore 1{\cdot}005 - {\cdot}01575 =$ the cost of \$1 $= \${\cdot}98925$;
$\therefore \$1{,}200 \div {\cdot}98925 = \$1{,}213.04 +$.

(6) Second cost $= \frac{6}{5}$ first cost; $\therefore$ selling price will be $\frac{5}{6}$ as great a gain per cent. on second cost as it is on first cost;

$\frac{6}{6} - \frac{5}{6} = \frac{1}{6} = 25\%$, $\therefore \frac{6}{6}$ gain per cent. $= 150\%$.

Verification:—$100 \times \frac{150}{100} = 120 \times \frac{125}{100}$.

(7) If \$100 = C's, then \$150 = B's, and \$225 = A's.
Hence A has 125% more than C;

C has $\frac{4}{9}$ of A's, or $\frac{5}{9}$ less than A, *i.e.* $55\frac{5}{9}\%$ less.

(8) First income $= 4{,}875 \times \frac{2}{195} \times 3 = 150$

2nd income $= 4{,}875 \times \frac{2}{195} \times \frac{99}{110} \times 4 = 180$. Increase = \$30.

(9) Expenses = 55%, net earnings = 45% of \$500,000 = \$225,000
Rate = 225 on 5,000, 9 on 200, $4\frac{1}{2}\%$.

(10) The final value at the end of 8 yr. of \$10 invested at the end of 6 mo. and every following 6 mo. at 10% compound interest $= 10[(1{\cdot}1)^7 \times (1.05) + (1{\cdot}1)^7 + (1{\cdot}1)^6 \times (1.05) + (1{\cdot}1)^6 + \text{etc.} \ldots + 1{\cdot}1 + 1.05 + 1]$

{N.B.—Sum of first two terms $= 1{\cdot}1^7 \times 2.05$, of second two $= 1{\cdot}1^6 \times 2.05$, etc.},

hence sum $= 20.50[1{\cdot}1^7 + 1{\cdot}1^6 + 1{\cdot}1^5 + 1{\cdot}1^4 + 1{\cdot}1^3 + 1{\cdot}1^2 + 1{\cdot}1 + 1] = 20.50\,\dfrac{1{\cdot}1^8 - 1}{1{\cdot}1 - 1}$

{N.B.—$x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1 = (x^8 - 1) \div (x - 1)$}

$= 205(1{\cdot}1^8 - 1)$. This is the amount of the debt Jan. 1, 1900.

Its P. worth $= 205(1{\cdot}1^8 - 1) \div (1{\cdot}1)^8 = 205\left(1 - \dfrac{1}{1{\cdot}1^8}\right) = 205 - \dfrac{205}{1{\cdot}1^8}$

$= 205 - \dfrac{20500000000}{214358881} = 205 - 95.63 = \$109.37$, cash value.

{N.B.—$11^8 = (11^2 \times 11^2)^2 = (121^2)^2 = 14{,}641^2 = 214{,}358{,}881$.}

Paper C (Page 52).

(2) $440d. + 14\frac{1}{4}d. + 350d. = £3\ 7s.\ 0\frac{1}{4}d.$

(3) The cost is the same. Paper at 9c., 27 in. wide, costs the same per square yard as paper at 24c., 24 in. wide.

(4) L. C. M. = product ÷ G. C. M.
$\therefore 634{,}938{,}944{,}494 \times 9{,}187 \div 85{,}044{,}059 = 68{,}590{,}142.$

(5) At first chicory $= \dfrac{3}{7} = 270$ lb. $= \dfrac{7}{17}$ of 2nd mixture.

$\therefore$ 2nd mixture $= \dfrac{17}{7} \times 270 = 655\frac{5}{7}$ lb., coffee added $= 25\frac{5}{7}$ lb.

(6) Interest $= \dfrac{12}{15}$ of $\dfrac{1}{10} = \dfrac{2}{25}$, $\therefore$ discount $= \dfrac{2}{27} = 7\frac{11}{27}\%$.

(7) $\left(\dfrac{2}{5}\text{ capital} \div 90\right) \times 3\frac{1}{2} + \left(\dfrac{3}{5}\text{ capital} \div 95\right) \times 4 = \$1{,}340$

$\text{capital}\left(\dfrac{7}{450} + \dfrac{12}{475}\right) = \$1{,}340$

$\text{capital}\left(\dfrac{7}{18} + \dfrac{12}{19}\right) = 1{,}340 \times 25 = \dfrac{349}{342}\text{ capital}$

$\therefore \text{capital} = \dfrac{1340 \times 25 \times 342}{349} = \$32{,}828.08.$

(8) If the first payment is made at the time of purchase, and $\$x$ is the annual payment, then

$x(1 + 1.06 + 1.06^2 + 1.06^3) = \$9{,}000$

i.e. $x \times 4{\cdot}374616 = 9{,}000$; $x = \$2057{\cdot}323$.

(9) Shell = external − internal dimensions

$$= \frac{4}{3}\pi r^3 - \frac{4}{3}\pi r^3 = \frac{4}{3}\pi (r^3 - r^3)$$

$$= \frac{4}{3} \times \frac{22}{7}\left[\left(\frac{7}{2}\right)^3 - \left(\frac{5}{2}\right)^3\right] = \frac{11}{21} \times 218 = 114{\cdot}19 + \text{cub. in.}$$

(10) Let x be the top of the tower, y its base on the bank, z the point on the water, w the position of the observer's feet, and s that of his eye. Then $ws = 5$ ft., $wz = 29$, $yz = 1{,}400 - 87 = 1{,}313$ ft. But the triangles xyz and swz are equiangular and similar and have their sides proportional,

$\therefore 87 : 5 = 1{,}313 : xy$; *i.e.* $87xy = 5 \times 1{,}313$

$xy = (5 \times 1{,}313) \div 87 = 75{\cdot}489$ ft.

Paper D (Page 53).

(1) $20d. + 3\frac{9}{11}d. = 23\frac{9}{11}d. = 1s.\ 11\frac{9}{11}d.$

(2) Expression = sq. rt. of $\dfrac{8640 \times 753}{391} = 12^2 \times 3^2 \times 2^2 \times \dfrac{1255}{391}$

$= 72 \times$ square root of $3{\cdot}209718 + = 72 \times {\cdot}5664 = 41$ nearly.

(3) $1\frac{5}{9}\frac{4}{9}\frac{7}{9}\frac{8}{9} \times 10{\cdot}618 \div 2\frac{5}{9}\frac{5}{9}\frac{4}{9}\frac{7}{9} = 15{,}475 \times 10{\cdot}618 \div 26{,}545$
$= 3095 \times 10{\cdot}618 \div 5{,}109 = {\cdot}006432 + .$

(4) $\frac{1}{5}$ *less* in price will require $\frac{1}{4}$ *more* in number of apples

$\therefore$ 120 apples $= \frac{1}{4}$ number for \$5; number = 480 apples.

(5) 1 man + 1 woman + 2 boys + 1 girl get \$100; and per question

(2 boys + 1 girl) + (2 boys − 1 girl) + 2 boys + 1 girl get \$100

i.e. 6 boys + 1 girl get \$100. (A)

Again: 1 man + 1 girl get \$50; and by the conditions this means (2 boys + 1 girl) + 1 girl get \$50, or

1 boy + 1 girl get \$25. (B)

Compare B with A, and 5 boys get \$75; and the shares are, each boy \$15, the girl \$10, the woman \$20, and the man \$40.

(6) 1 metre = $39\frac{3}{8} \div 36 = \frac{35}{32}$ yd.; 1 franc = £$\frac{1}{25}$;

42 centimes = £$\frac{42}{2500}$

No. yards bought = £1,000 ÷ £$\frac{3}{20}$ = 20,000 ÷ 3; 3*d.* = £$\frac{1}{80}$

No. metres sold = $\frac{20000}{3} \times \frac{32}{35}$; one-half at 8, one-half at 6 = whole at 7 francs per metre. Hence the gain on whole

$$= £\left(\frac{20000}{3} \times \frac{32}{35} \times \frac{7}{25}\right) - £\left\{\left(1000 + \frac{20000}{3} \times \frac{1}{80}\right) + \left(\frac{20000}{3} \times \frac{32}{35} \times \frac{42}{2500}\right)\right\}$$

$$= £\left(\frac{20000}{3} \times \frac{32}{35} \times \frac{7}{25}\right)\left(1 - \frac{6}{100}\right) - \left(1000 + \frac{20000}{3} \times \frac{1}{80}\right)$$

$$= \frac{20000}{3} \times \frac{32}{35} \times \frac{7}{25} \times \frac{94}{100} - 1000\left(1 + \frac{1}{12}\right)$$

$$= \frac{8 \times 32 \times 94}{15} - \frac{13000}{12} = \frac{7814}{15} = £520\ 18s.\ 8d.$$

(7) Int. − dis. = \$38.84 = int. on dis. = interest on \$310.72

Rate = 3,884 ÷ 31,072 = $\frac{1}{8}$ = 12½%

Sum = \$349.58 × 8 = \$2,796.64; rate per annum = 6¼%.

(8) Price of wheat = \$6,000; ∴ 6,000 − 500 = 5,500 cost of silk 4% = $\frac{1}{25}$; 2nd com. = \$220; 1st com. = \$280 on \$6,000; rate = 4⅔%.

(9) $\pi r^2 \times 18 = 3 \times 1{,}728$; $r^2 = (3 \times 1{,}728) \div \left(\frac{22}{7} \times 18\right) = 144 \times \frac{7}{11}$

$\therefore r = 12\sqrt{\frac{7}{11}}$ in. = $\sqrt{\frac{7}{11}}$ ft. = diameter = $2\sqrt{\frac{7}{11}} = 1{\cdot}59$ ft.

(10) Let y and $4y$ be the the segments of hyp., then $5y$ = hyp. Let a and b be the sides of triangle; then $a^2 + b^2 = 25y^2$, Euc. I. 47. But by the same theorem $a^2 = 16y^2 + 10^2$, $b^2 = y^2 + 10^2$. Hence $a^2 + b^2 = 17y^2 + 200$; $\therefore 25y^2 = 17y^2 + 200$; $y^2 = 25$; $y = 5$, hyp. = 25. Area = $\frac{1}{2} \times 25 \times 10 = 125$.

PAPER E (PAGE 54).

(1) Yes, if we explain it in such a way as to keep the multiplier an abstract number *e.g.*, if the stamps cost 1c. apiece the price would be 6c.; at 3c. apiece the price will be 6c. $\times$ 3 = 18c.

(2) When a unit is divided into equal parts there are two things to be considered, viz., (*a*) the NUMBER, (*b*) the SIZE of these equal parts. The numerator expresses the *number* and the *denomintor* the size.

Proofs—$\frac{3}{4} \div 5$ = quotient; $\frac{3}{4}$ = 5 times the quotient;

$\frac{3}{4} \times 4 = 20$ times the quotient. Now $\frac{3}{4} + \frac{3}{4} + \frac{3}{4} + \frac{3}{4} = 3$

$\therefore$ 3 = " " Quotient $= \frac{3}{20}$.

(3) Area of one face = 16; $\therefore$ edge = 4; $\therefore$ internal edge = 1. Solidity of box $= 4^3 - 1^3 = 63$ cub. ft. This will weigh as much as $63 \times \frac{4}{3}$ of second metal = 84 cub. ft. Again the surfaces of the three cubes are as 1 : 4 : 9; $\therefore$ their faces are as $\frac{1}{6} : \frac{4}{6} : \frac{9}{6}$ *i.e.* as 1 : 4 : 9, and their edges as 1 : 2 : 3, and their solid contents as 1 : 8 : 27, hence $36x^3$ will represent their combined mass.

Thus $36x^3 = 84$; $x^3 = \frac{7}{3}$, $x = \sqrt[3]{7} \div \sqrt[3]{3}$,

or $x = 1{\cdot}912931 \div 1{\cdot}442250 = 1{\cdot}3263518$.

And the sides are as 1·3263518 : 2·6527036 : 3·9790554.

(4) Compound interest on \$500, 3 yr. at 5% = \$78$\frac{1}{16}^3$
Simple for 1 yr. must be \$78$\frac{1}{16}^3 \div 15$ = \$5$\frac{61}{240}$ for 1 yr.
= interest on \$100 for 1 yr. at 5$\frac{61}{240}$%. ANS. \$100.

(5) The times are $\frac{1}{12}$, $\frac{1}{6}$ and $\frac{1}{4}$ of a year respectively.

The interests on \$1 at 4% for these times are $\frac{1}{300}$, $\frac{2}{300}$, $\frac{3}{300}$;

the discounts are therefore $\frac{1}{301}$, $\frac{2}{302}$ and $\frac{3}{303}$.

A table may therefore be made thus:

No. days	30	60	90	
Fraction of Face	$\frac{1}{301}$	$\frac{2}{302}$	$\frac{3}{303}$	to find Discount.

(6) A runs 120 yd., B 110 yd., C 99 yd. in the same time;
$\therefore$ C's speed is $\frac{9}{10}$ B's speed; $\therefore$ B runs 120 while C runs $\frac{9}{10}$ of $120 = 108$; difference $= 12$ yd. = distance run by C in $1\frac{1}{2}$ sec.;
$\therefore$ C runs 120 yd. in 15 sec.; B in $13\frac{1}{2}$; A in $12\frac{3}{8}$ sec.

(7) \$1 in the $3\frac{1}{2}$ per cents produces $\$3\frac{1}{2} \div 80 = \frac{980}{22400}$

" " 5 " " $\$5 \div 112 = \frac{1000}{22400}$

\$1 in both, as per question, produces $\$44\frac{1}{16} \div 100 = \frac{987}{22400}$

The interests on the three investments are therefore in the proportion of 980 : 1,000 : 987. The average is 987; the 1st gives 7 *less*, and 2nd 13 *more* than the average rate; to produce the average these proportions must be reversed in the investments, *i.e.* for every 13 of the 1st there must be 7 of the 2nd, or of \$1,000, \$650 in the $3\frac{1}{2}$ per cents and \$350 in the 5 per cents. The incomes are $\$28\frac{7}{16} + \$15\frac{10}{16} = \$44\frac{1}{16}$, the average.

(8) Area of floor $= 24 \times 18 = 432$ sq. ft. $= 48$ sq. yd.
Area of centre $= (24-6)(18-6) = 216$ sq. ft. $= 24$ sq. yd. carpet
Area of margin $= 432 - 216 = 216$ sq. ft. $= 24$ sq. yd. painting
Cost of carpet $= 24 \times \frac{3}{2} \times 4\frac{1}{4} = 153s.$
Cost of painting $= 171 - 153 = 18s.$;
cost of 1 sq. yd. $= 18s. \div 24 = 9d.$; cost of 1 sq. ft. $= 1d.$

(9) $AO = \sqrt{(AB^2 - BO^2)} = \sqrt{(159^2 - 84^2)} = 135$, Euc. I. 47.
$CO = \sqrt{(BC^2 - BO^2)} = \sqrt{(105^2 - 84^2)} = 63$
$\therefore AC = 135 + 63 = 198$
Area of $ABC = \frac{1}{2}(198 \times 84) = 8{,}316$

Triangle ADC has sides 161, 90, 198; the area is found from the formula $\sqrt{s(s-a)(s-b)(s-c)}$, where $s = \frac{1}{2}(a+b+c)$ and a, b, c are the sides. Hence area of ADC $= \frac{1}{4}\sqrt{(449 \times 53 \times 269 \times 127)} = \frac{1}{4}\sqrt{(812{,}976{,}911)} = 7{,}128 +$
Hence area of ABCD $= 7{,}128 + 8{,}316 = 15{,}444$ nearly.
To find DP we have $7{,}128 = \frac{1}{2}\,AC \times DP = 99DP$
$\therefore$ DP = 72 nearly.

(10) The volumes, *i.e.* the weights are proportional to the cubes of the diameters; $W : W_2 = 7^3 : 10^3$, or $10 : W_2 = 7^3 : 10^3$
$\therefore W_2 \times 7^3 = 10^4$; $W_2 = 10^4 \div 7^3 = 29\frac{53}{343}$ lb.

Paper F (Page 54).

(1) A dollar becomes 1·012 at the end of the first year, 1·024144 at the end of the second, 1·036433728 at the end of the third, and the income for the fourth year is $\cdot06218602368 \times 15566\cdot6 = \$968\cdot024956 +$.

More concisely:—Income $= 15{,}566.60 \times \left(\frac{506}{500}\right)^3 \times \frac{6}{100} =$ \$968·024956117; since there is added $\frac{1}{5} \times \frac{6}{100}$, or $\frac{6}{500}$ of the principal each year.

(2) Price $= \left[\frac{112}{100}(2{,}000 + 280 + 75 + 30) - 150\right]\frac{1}{21} = \$120.05\frac{5}{7}$

(3) Int. for $2\frac{1}{4}$ yr. = \$213.75; for 1 yr. = \$95; rate = $6\frac{1}{4}\%$.

(4) Shares are as 71, 110, 120; A $\frac{71}{301} \times 9{,}800 = \$2{,}311.62$;
B \$3,581·395; C \$4,106.97.

(5) Note has 60 dy. to run, discount $= \frac{1}{100}$; P.W. $= \frac{99}{100}$

New note has 90 dy. to run, discount $= \frac{3}{200}$; P.W. $= \frac{197}{200}$

$\therefore$ face $\times \frac{197}{200} = 6{,}000 \times \frac{99}{100}$; face = \$6,030.46.

(6) Cost $= \frac{40}{9} \times \frac{109\frac{1}{2}}{100} \times \frac{100\frac{1}{8}}{100} \times 416\frac{7}{16} = \$2029\cdot195.$

(7) $137\frac{1}{2}$ yields 10; 275 pays 20; 100 pays $20 \times \frac{4}{11} = 7\frac{3}{11}\%$.

(8) Value $= 24\frac{3}{4} \times \frac{175}{144} \times 12 \times \frac{18}{22} \times 17\frac{5}{8} = \$5{,}204.88 +$.

(9) Dist. outside tunnel $= 115\frac{1}{2}$ mi., time in tunnel $= 10\frac{5}{16}$ min.
Time outside tunnel, actual running $= 216\frac{1}{16}$ min.
Rate per hour $= 115\frac{1}{2} \div 216\frac{1}{16} \times 60 = 31\cdot982 +$ mi. per hour.

(10) Distance round room = 83 ft.; total area of walls = 913 sq. ft.; area of doors, etc. = $137\frac{1}{3}\frac{3}{6}$ sq. ft.; area to be papered = $775\frac{2}{3}\frac{3}{6}$ sq. ft.; area of one roll paper = 72 sq. ft.; number rolls = $775\frac{2}{3}\frac{3}{6} \div 72 = 10{\cdot}7727$; *i.e.* 10 rolls and 18 ft. 6·53 in.

Paper G (Page 55).

(3) Expression $= \frac{1}{2} - \frac{12}{13} \times \frac{64743583}{999999900} = \frac{953846059}{2166666450}$.

(2) £2·8; 6·96 cwt.; 2·32 cwt. for soap; 4·64 cwt. for cash. Cash = £12 19*s.* $10\frac{2}{5}d.$; soap = $346\frac{3}{5}\frac{4}{5}$ lb.

(3) 20 min. apart at 4 o'clock; $21\frac{8}{1}\frac{}{1}$ min. past 4 o'clock. Ans.

(4) $17\frac{3}{5}$ dy., and $27\frac{1}{1}\frac{}{3}$ dy.

(5) 9; 350.

(6) $11\frac{3}{4}$ lb.

(7) 7 chains $14\frac{2}{7}$ links.

(8) \$1,200, \$450, \$270.

(9) $\$4{,}384.61\frac{7}{1}\frac{}{3}$.

(10) 800 × 500 × 10 = 1,000 × 400 × 10. Ans. 500 men.

Paper H (Page 56).

(1) The portions are as 3 : 5 : 7; let 300, 500, 700 bush. be sold and the profits taken *in wheat*. Then 139 bush. is the profit on 1,500; but at 10% the profit would be 150 bush.; gain = 11 bush. on 1,500 sold; or $\frac{11}{1500}$ cost = $\$16.68\frac{1}{3}$; \$2,275 Ans.

(2) 6% receipts = \$28,350; 54% = 28,350 × 9 = $3\frac{1}{2}$% of stock; stock = \$729,000. Ans.

(3) The difference between the ages is constant.
A's : B's = 9 : 7; A's : A's − B's = 9 : 2
A's age *is* $4\frac{1}{2}$ times the difference. Formerly A's : B's = 5 : 2;
∴ A's age : A's − B's = 5 : 3; A's *was* $1\frac{2}{3}$ times the difference;
∴ A's present age : A's former age = $4\frac{1}{2} : 1\frac{2}{3}$ = 27 : 10
∴ $\frac{17}{27}$ A's present age = 34; A's 54, B's 42. Ans.

(4) In a certain time, rate in still water + rate of tide = 5 mi.
" " " " − " " = 3 mi.
∴ " " " " $= \frac{1}{2}(5 + 3) = 4$ mi.

" " rate of tide = 1 mi. $= \frac{1}{4}$ rate of man in still water. Similarly, if 2 and 1 are the *down* and the *up* rates, $1\frac{1}{2}$ will be rate in still water, and $\frac{1}{2}$ rate of tide $= \frac{1}{3}$ rate of man in still water. ∴ $\left(\frac{1}{3} - \frac{1}{4}\right)$ rate in still water $= \frac{1}{2}$ mi. per hour

∴ rate in still water = 6 mi. per hour.

(5) A's income $= 40 \times \frac{100}{104} \times 5 = 2{,}500 \div 13 = \$192.30\frac{10}{13}$

A's proceeds $= 4{,}000 \times \frac{102}{104} = \$3{,}923.07\frac{9}{13}$

B's income $= 40 \times \frac{100}{91} \times \frac{10}{3} = \$146.52\frac{4}{273}$

B's proceeds $= 4{,}000 \times \frac{98}{91} = \$4{,}307.69\frac{3}{13}$

(6) Int. of \$1, 9 mo. at 8% $= \frac{3}{50}$; discount $= \frac{3}{53}$; P.W. $= \frac{50}{53}$

" " 3 " " $= \frac{1}{50}$; " $= \frac{1}{51}$; " $= \frac{50}{51}$

∴ gain $= 80\left(\frac{50}{51} - \frac{50}{53}\right) = 4{,}000\left(\frac{1}{51} - \frac{1}{53}\right) = 8{,}000 \div (51 \times 53)$

gain per cent. $= \frac{80.00}{51 \times 53} \times \frac{100}{80} = \frac{10000}{2703} = 3{\cdot}7$ nearly.

(7) If 75 shares represent the whole property, 33, 24, and 18 shares represent the farms. Each should get 25 shares. A pays B 1 share, and C 7 shares; *i.e.* $\frac{1}{75}$ and $\frac{7}{75}$ of \$2,000,

or $\$26.66\frac{2}{3}$, $\$186.66\frac{2}{3}$.

(8) Perpendicular = area × 2 ÷ 10 = $\frac{6}{10}\sqrt{399} = 11{\cdot}985$ ft.

(9) Side² × 2 = 4²; side² = 8 sq. ch. = area = 128 sq. rods.

(10) Solidity of ball $= \frac{68}{450}$ cub. ft. $= \frac{4}{3} \times \frac{355}{113}$ solidity of cube whose side = radius of ball;

$$\therefore \text{ solidity of cube} = \frac{68}{450} \times \frac{3}{4} \times \frac{113}{355} \times 1{,}728 \text{ cub. in.}$$

$$= \frac{4 \times 17 \times 3 \times 113 \times 12^3}{900 \times 10 \times 71} = \frac{12^3 \times 17 \times 113}{5^3 \times 71 \times 6} = (\text{radius of ball})^3$$

Diameter of ball $= \frac{24}{5}$ cube rt. of $\frac{1921}{426} = \frac{24}{5} \sqrt[3]{4{\cdot}509389} = 7{\cdot}932$ in.

Paper K (Page 57).

(1) Q. $= \left(28 \div \frac{24}{5}\right) - (9\frac{1}{12} - 5\frac{7}{8}) = 1\frac{8}{24}$.

(2) Reduce fractions to common numerator, 144. The greatest fraction will then have the least denominator and *vice versâ*. The fractions are already in the order of magnitude, the first being greatest.

(3) Area of 1st $= \frac{1}{9}$ area of 2nd = 104,976 sq. in.;

side of 1st = 9 yd.; area of 3rd = 16 area of first;
side of 3rd = 4 × 9 = 36 yd.

(4) Mother's age $= \frac{356}{420}$ of 35 $= 29\frac{8}{12}$ yr., eldest child's age = $3\frac{3}{12}$ yr., and youngest child's age = $2\frac{1}{12}$ yr. Difference between mother's age and eldest child's age *at starting* $= 26\frac{5}{12}$ yr.; *at end of voyage* difference is represented by 728 − 94 = 634 units; or difference is $\frac{634}{728}$ mother's age. The difference between their ages is constant, therefore $\frac{634}{728}$ mother's age $= 26\frac{5}{12}$ yr.;

mother's age at *end* of voyage = 30 yr. 4 mo. Her age at *starting* 29 yr. 8 mo.; time of voyage = 8 mo.

(5) Interest for 1 yr. at 4% is \$5·815, which × 2 = \$11.63, and the smallest multiplier that will make this an integer is 100.
Ans. 200 yr.

(6) Simple interest = \$866·486
Compound interest = \$890·957; difference = \$24.47.

(7) The capitals at the beginning of each year are as follows: \$800, \$720, \$636, \$547.80, \$455.19, \$357·9495, \$255·846975.
Ans. \$255.84.

(8) Let number of hours before meeting $= x$. and we have
A's rate : B's rate $= x : 36$; also
A's rate : B's rate $= 16 : x$
$\therefore x : 36 = 16 : x$; or $x^2 = 16 \times 36$, $x = 24$ hr.
The times are $24 + 16 = 40$ for A; $24 + 36 = 60$ for B.

(9) Rate of interest $= \frac{3}{99} = \frac{1}{33}$. Interest for 9 mo. $= \frac{1}{44}$;

discount $= \frac{1}{45}$; P. W. $= \frac{44}{45} \times 150 = \$146\frac{2}{3}$.

(10) Whole solidity $= \frac{4}{3} \times \frac{22}{7} \times \left(\frac{13}{2}\right)^3$ cub. in.

Hollow space $= \frac{4}{3} \times \frac{22}{7} \times \left(\frac{9}{2}\right)^3$ cub. in.

Solidity of shell $= \frac{4}{3} \times \frac{22}{7} \times \frac{1468}{8}$ and this $\times \frac{441}{1728} = 196\frac{3}{4}\frac{5}{4}$ lb.

Paper M (Page 59).

(1) The sides are as 3 : 2; 360 ft. is the least distance that will contain 5, 8 or 9 ft. exactly; $\therefore 3 \times 360$ and 2×360, or 1,080 ft. by 720 ft. is the least rectangle.

(2) Weight $= \frac{5}{6}$ weight of gold $+ \frac{1}{6}$ weight of alloy.

Value $= \frac{5}{6}$ gold $+ \frac{1}{300}$ gold $= \frac{251}{300}$ gold $= 21s. = \frac{21}{78}$ oz.;

weight of gold $= \frac{21}{78} \times \frac{300}{251} = \frac{1050}{3253}$ oz.

(3) $\frac{\text{Sum}}{97\frac{1}{2}} \times 6 = \$600$; sum $= 100 \times 97\frac{1}{2} = \$9,750$.

(4) $4,500 \div 90 = 50$ shares
Int. on 4,500 for 3 mo. $= \$90$; received $30 \times 95 = 2,850$, bal. \$1,650
" 1,650 for 3 mo. $= \$33$; " $20 \times 87 = 1,740$
Total interest $= \$123$; profit on sales $= \$90$
Loss on the transaction $123 - 90 = \$33$.

(5) A year = 360 dy. nearly ; $\therefore$ int. on \$1 for 1 dy. = 6c. $\div$ 360 $= \frac{1}{6}$ mill. Hence interest on any sum

$= \frac{1}{6}$ mill $\times$ days $\times$ sum $= 1$ mill $\times \left(\frac{\text{days}}{6} \times \text{sum}\right)$,

which is the rule.

(6) Int. $= \frac{7}{300}$ face, $\therefore$ disc. $= \frac{7}{307}$ face, $\therefore$ proceeds $= \frac{300}{307}$ face

$\therefore \frac{300}{307}$ face $= 1{,}267$; face $= 1{,}267 \times \frac{307}{300} =$ \$1,296.56$\frac{1}{3}$.

(7) At *simple interest*, $(1 + 3r)\,100 = 120\left(1 + \frac{14}{100}\right)$

$\therefore 1 + 3r = 1{\cdot}368$; $3r = {\cdot}368$; $r = 12\frac{4}{15}\%$.

At *compound interest*, $100\,(1 + r)^3 = 120\left(1 + \frac{7}{100}\right)^2$,

$\therefore (1 + r)^3 = \frac{12}{10}(1{\cdot}07)^2 = 1{\cdot}37388$

$1 + r =$ cube root of $1{\cdot}37388 = 1{\cdot}1116+$, $r = 11\frac{4}{25}\%$ nearly.

(8) Compound interest must be taken ; amount of mortgage
$= 250\,(1{\cdot}07^2 + 1{\cdot}07 + 1) =$ P. W. $\times\, (1{\cdot}07)^3$
P. W. $= 250\,(1{\cdot}07^2 + 1{\cdot}07 + 1) \div 1{\cdot}07^3$
$= 803{\cdot}725 \div 1{\cdot}225043 =$ \$656.08.

(9) Cost prices, 60 and 42 ; and 51 pence.

Then $\frac{100 - r}{100} \times 60 = \frac{100 + r}{100} \times 42$; $\therefore r = \frac{300}{17}\%$

$\therefore$ selling price $= 42 + \frac{3}{17} \times 42 = 49\frac{7}{17}d$.

Loss on 51 $= 1\frac{9}{17}$; $\therefore$ loss per cent. $= 3\frac{3}{8}\frac{3}{6}\%$.

(10) If the planes of the rectangles are all perpendicular
$x =$ number feet in shortest edge, $\therefore 6x^3 = 786$ cub. ft.
$x^3 = 131$; $x = 5{\cdot}078753$, $2x = 10{\cdot}15750$
$3x = 15{\cdot}236259$, the lengths of the edges.

Paper N (Page 60).

(1) $\frac{213}{286} \times \frac{13}{71} \times \frac{22}{3} = 1\,;\ \frac{9}{13}$.

(2) $98{,}400{,}180 \div 159{,}982 = 615{\cdot}070320$.

(3) $150 \times 6 \times \frac{3}{2} \times 1{,}728 \div (9 \times 4\frac{1}{2} \times 3{,}000) \times 6.25 = \$120$.

(4) $(1{,}500 \times 54) + (1{,}100 \times 209) + (600 \times 102) = 372{,}100 =$ amount at interest for 1 dy. at 8%. Interest = \$81.56.
Ans. \$681.56.

(5) 1st income $= 250 \times 8 = \$2{,}000$

2nd income $= 250 \times \frac{120}{125} \times 8\frac{1}{2} = \$2{,}040$; increase = \$40.

(6) The losses are 4, 3, 2; gains 1, 2;
these must be made equal; so we may take
20 at 8c., 40 at 9c., 100 at 10c., 80 at 13c., 160 at 14c.,
and countless other combinations.

(7) Find the value of 2,000 oz. and take one-6323rd.

$\frac{37}{40}$ of 2,000 at \$17 = 31,450

$\frac{3}{40}$ of 2,000 at $\$\frac{11}{10} = \frac{165}{31615} \div 6323 = \$5$. Ans.

(8) $\$\frac{40}{9} \times \frac{110\frac{1}{4}}{100} = £1 = 26{\cdot}85$ francs

12,000 francs $= \frac{40}{9} \times \frac{441}{400} \times \frac{100}{2685} \times 12{,}000 = \$2.413.41$.

(9) Value : value = weight : weight = 4 : 5 = volume : volume.
Area : area = 100 : 121

$\therefore$ thickness : thickness $= \frac{4}{100} : \frac{5}{121} = 121 : 125$. Ans.

(10) They travel together 231 yd. in $6\frac{3}{4}$ sec., *i.e.* 70 mi. per hour. Also 231 yd. is the difference between the distances they travel in $47\frac{1}{4}$ sec., *i.e.* the difference is 10 mi. for 1 hour's travel.
Ans. 30 mi., 40 mi.

THIRD CLASS.

1871 (PAGE 81).

(1) 701,014,000,120,014,009 ; 701 quadrillions, etc.

(2) Write A.M. after 11 o'clock ; 8 yr. 11 mo. 13 dy. 19 hr. 5 min.

(3) G. C. M. of $3 \times 17 \times 71$ and $3 \times 17 \times 31$ is 51.

Principles :—(*a*) Every measure of A will also measure any multiple of A ; (*b*) every measure of A and B will also measure the sum or the difference of any multiples of A and B.

(4) L. C. M. of 140 eighths and 85 eigtths $= \frac{595}{2} = 297\frac{1}{2}$.

(5) (*a*) A fraction is increased by increasing in any way the NUMBER of the equal parts, *i.e.* by multiplying the *numerator*, or by adding something to it. (*b*) A fraction is decreased by diminishing the NUMBER of the equal parts, *i.e.* by dividing the *numerator*, or by subtracting something from it. (*c*) A fraction is made less by diminishing the SIZE of the equal parts, *i.e.* by multiplying the *denominator*, or by adding something to it. (*d*) A fraction is made greater by increasing the SIZE of the equal parts, *i.e.* by dividing the *denominator*, or by subtracting something from it. All the rules of fractions depend on applications of these principles.

$$\frac{31}{21} \times \frac{443}{80} \times \frac{26}{10} = 21\tfrac{231}{400}.$$

(6) $2\frac{2}{4} + 2\frac{1}{12}$ ac. $= 4\frac{7}{8}$ ac. $= 4$ ac. 140 per.
$(9\frac{1}{2} \div 25\frac{1}{3})$ roods $=$ 15 per.
$\left(\frac{3}{11} \text{ of } 1\frac{1}{11}\right)$ per. $=$ 9 yd.

	4	155	9
Subtract	4	25	12
		129 pr.	$27\frac{1}{4}$ yd.

(7) $\frac{3}{4}\left(\frac{4}{9}\text{ farm} + 80\text{ ac.}\right) + \left(\frac{4}{9}\text{ farm} + 80\text{ ac.}\right) = \text{farm}$

$\therefore \frac{7}{4}\left(\frac{4}{9}\text{ farm} + 80\text{ ac.}\right) = \text{farm}$

$\therefore 140\text{ ac.} = \frac{2}{9}\text{ farm.}$ ANS. 630 ac.

(8) Sum $= 3{\cdot}88\dot{2}$; difference $= 3{\cdot}03\dot{1}$
Product $= 3{\cdot}45\frac{5}{9} \times {\cdot}42\frac{5}{9} = (31{\cdot}11 \times 3{\cdot}83) \div 81 = 1{\cdot}4710037.$

(9) £2·25 × 2·7345 = £6·152625
5·5625 ac. × 2·7345 = £15·21065625 ac.
6·5⅓ oz. × 2·7345 = 17·8654 oz.

(10) ($331.62½ − $78.37½) ÷ 209 = 1.21\frac{36}{99}$ per hundred feet.

(11) $5 ÷ $4.86⅔ $= \frac{300}{292}$; $2,720.40 × $\frac{300}{292}$ = $2,794·923 +.

(12) 95% sales = $4,100; sales = $4,315.79 nearly.

(*b*) Commission = 5 on 105; $\frac{1}{21}$ of $4,100 = $195.24 nearly.

1872 (PAGE 82).

(1) Increase $= \frac{1}{9} = 11\frac{1}{9}\%$.

(2) Number $\div \frac{9}{19 \times 13} = \frac{247}{11}$. Number $= \frac{9}{11}$.

(3) 103.04 + 40.33 + 27.38$\frac{17}{32}$ + 34.40$\frac{13}{16}$ + 6.75 + 21 + 60.21$\frac{3}{32}$ = 293.12\frac{7}{16}$.

(4) 25 + 33 + 42 + 40 = 140; 10,500 ÷ 140 = 75;
A's share is 25 × 75 = $1,875; B's, $2,475;
C's, $3,150; D's, $3,000.

(5) Gain per M. = $3⅛; 106¼ M. at 3⅛ = $332.03⅛.

(6) 18c. per yard = 2c. per foot
Walls, $17.02⅔ + ceiling, $7.30 = $24.32⅓.

(7) Number hours $= \frac{25 \times 20 \times 3 \times 60 \times 12 \times 9}{40 \times 15 \times 2 \times 50 \times 25} = 6\frac{2}{5}$ hr.

(8) The price is *decreased* by $\frac{1}{5}$ of itself, $\therefore$ quantity must be *increased* by $\frac{1}{4}$ of itself = 150 gal.

(9) $\$5.84 \times \frac{360}{126} = \$16.68\frac{4}{7}$.

(10) Int. $= \frac{12}{100} \times \frac{8}{12} = \frac{2}{25}$; disc. $= \frac{2}{27}$; P. W. $= \frac{25}{27}$ of $\$6\frac{1}{4} = \$\frac{625}{108}$

In 2nd case int. $= \frac{1}{25}$; disc. $= \frac{1}{26}$; P. W. $= \frac{25}{26}$ of $\$6\frac{1}{2} = \$\frac{675}{108}$

Gain per barrel $= \$\frac{50}{108}$, which $\times$ 500 $= \$231{\cdot}48\frac{4}{27}$.

1873 (Page 83).

(1) $\frac{25}{196}$.

(2) $\frac{120}{13} = \$9.23\frac{1}{13}$.

(3)
$\cdot\dot{4}\dot{7}8\dot{7}8\dot{7}8\dot{7}8\dot{7}\dot{8}$
$\cdot3\dot{2}1\dot{3}21\dot{3}21\dot{3}\dot{2}\dot{1}\dot{3}$
$\cdot3\dot{2}\dot{2}2\dot{2}2\dot{2}2\dot{2}2\dot{2}\dot{2}\dot{2}$ *Two* to carry from the next line which
$\cdot7\dot{8}5\dot{6}485\dot{6}\dot{4}8\dot{5}\dot{6}\dot{4}$ is the same as the second line.
$\cdot\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}\dot{5}$
$\cdot4\dot{3}2\dot{6}432\dot{6}\dot{4}32\dot{6}\dot{4}$
$2\cdot8\dot{9}\dot{6}1\dot{7}88\dot{0}\dot{7}0\dot{6}\dot{9}\dot{8}$

(*b*) $1\cdot4710\dot{0}3\dot{7}$. See No. 8, 1871.

(4) Wall $= 100\frac{3}{4} \times 2 \times 22 = 4{,}433$
Roof $= 48\frac{1}{3} \times 60\frac{1}{2} = 2{,}924\frac{1}{6}$
Gables $= 523\frac{1}{4}$. Ans. $7{,}880\frac{5}{12}$ ft.

(5) 93 dy. $= \frac{93}{365}$ yr. at $\frac{7}{100} = \frac{651}{36500}$ int.; $\therefore$ disc. $= \frac{651}{37151}$

Difference $= 651\left(\frac{1}{36500} - \frac{1}{37151}\right) \times 2500 = \frac{21190050}{2712023} = \$0{\cdot}781$.

(6) $98 \times 12 \times 2 = \$23.52$; $30\frac{1}{2} \times 18\frac{1}{2} \times \frac{1}{9} \times \frac{4}{3} \times 180 = \$150.46\frac{2}{3}$.

(7) Killed = ·1; wounded = ·9 × ·05; difference ·055 of army
Army = 1,100 ÷ ·055 = 20,000 men.

(8) $\frac{108}{100}$ of my stock = 297; stock = 275 shares.

(9) Cubic foot of water weighs, say 1,000 oz.;
$\frac{15}{17}$ is O; $\frac{2}{17}$ is H. ANS. $882\frac{6}{17}$ oz.; $117\frac{11}{17}$ oz.

(10) 1 share yields \$60 cash, which purchases (96 ÷ 60) share paying \$7, ∴ (1,680 × 96) ÷ (60 × 7) = 384 shares.

(11) Cost = $100 \times \frac{94\frac{1}{2}}{5280} \times 640 \times \$24.75 = \$28,350$.

(12) $2\frac{1}{4}\% = \frac{9}{400}$; 2% on $\frac{3}{5} = \frac{6}{500}$; difference = $\frac{21}{2000}$ risk.
ANS. \$4,000.

1874 (PAGE 84).

(1) $(3\frac{1}{2} \times 1) + (7\frac{1}{2} \times 0 \times 425) = 3\frac{1}{2}$.

(2) 1 cub. yd. = 27,000 oz., of which $\frac{889}{1000}$, or 24,003 oz. is O, and 2,997 oz. is H.

(3) Each woman gets $\frac{1}{20}$ of 480 = \$24
∴ a man + a child gets \$48
15 men + 30 children get \$936
15 men + 15 children get \$720, etc.
Man, \$33.60; child, \$14.40.

(4) Debts = $\frac{8}{3} \times 6{,}300 = \$16{,}800$.

(5) Let x = width, ∴ $\frac{22\frac{1}{2} \times x}{9} \times \frac{4}{3} \times \frac{7}{4} = \$\frac{385}{4}$; $x = 16\frac{1}{2}$ ft.

(6) A man does $\frac{1}{51}$; boy $\frac{1}{85}$; 5 men and 3 boys do $\frac{1}{3}\left(\frac{5}{51} + \frac{3}{85}\right)$ of a job three times as big, *i.e.* $\frac{1}{51}\left(\frac{5}{3} + \frac{3}{5}\right) = \frac{2}{45}$. Time = $22\frac{1}{2}$ dy.

(7) $38\frac{1}{16} = 38{\cdot}6875$ yd.
Cost $= \$3{\cdot}825 \div 3.75 \times 38{\cdot}6875 = \$39{\cdot}46125$.

(8) $1 - \left(\frac{1}{2} + \frac{1}{5} + \frac{1}{6}\right) = \frac{4}{30}$ fortune $= \$8{,}000$; fortune $= \$60{,}000$.

(9) $1.06 \times 1.05 = \$1{\cdot}113$ = amount at end of 6 mo.
Loss $= (1{\cdot}125 - 1{\cdot}113)\ 9{,}000 = \$108$.

(10) $140 + 130 + 90 + 75 + 60 = 495$ marks out of $850 = 58\frac{4}{7}\%$.

1875 (Page 85).

(1) $\left(\frac{79}{3} \times \frac{2}{69}\right) \div \left(\frac{15}{13} + 7 - 7\frac{1}{8}\right) = \frac{79}{3} \times \frac{2}{69} \times \frac{104}{107} = \frac{16432}{22149}$.

(2) 1 hhd. $= 63$ gal. $= 1{,}008$ half-pints;
1 qt. + 1 pt. + 1 half-pint $= 7$ half-pints.
$1{,}008 \div 7 = 144 = 12$ doz. of each.
He must sell 1,008 half-pints for $175 \times \frac{23}{20}$;

$\therefore$ 1 doz. half-pints for $\$2.39\frac{7}{12}$; 1 doz. pints for $\$4.79\frac{1}{6}$;
1 doz. quarts for $\$9.58\frac{1}{3}$.

(3) 4 mo. $= \frac{1}{3}$ yr.; 12 dy. $= \frac{1}{30}$; time $= \frac{11}{30}$ yr.;

interest on \$1 $= {\cdot}033$; P. W. of \$1 $= {\cdot}967$;
Face of note $= 240 \div {\cdot}967 = \$248.20$ nearly.

(4) At first the shares are $\frac{1}{3}, \frac{1}{3}, \frac{1}{3}$; next $\frac{2}{9}, \frac{1}{4}, \frac{4}{15}$;

lastly A has $\frac{167}{540}$, B and C together have $\frac{373}{540}$;

$\therefore$ A must have $\frac{167}{373}$ of $\$37{,}300 = \$16{,}700$.

(5) \$20 for 500 = 4c. per bushel;
amount of 1.24 in 6 mo. at $8\% = \$1{\cdot}2896$
Loss at end of 6 mo. $= 500 \times {\cdot}0104 = \$5.20$; or \$5 cash.

(6) Ans. $17s.\ 9\frac{5}{11}d.$

(7) $\frac{4}{5}$ remainder cost \$1,344; remainder cost \$1,680;
20 barrels cost \$120; $\$1{,}800 \div \$6 = 300$ barrels.

(8) $133\frac{1}{3}$ greenback buys 100 gold; 10 greenback = \$7.50 gold.

(9) $151_{\frac{5}{7}} \times 35 = \text{No.} \times 15\frac{5}{8}$; $\therefore$ No. = 334 yd. 2 ft. $1\frac{1}{13}$ in.

(10) Tare $= \frac{14}{100}$; duty is collected on $\frac{86}{100}$

$\therefore$ duty $= 4 \times 1{,}280 \times \frac{86}{100} \times \frac{11}{4}$ cents = \$121·088.

(11) $293.05 \times \frac{40}{9} \times \frac{109\frac{1}{2}}{100} = \$1{,}426.17\frac{3}{8}$.

1876 (Page 85).

(1) 1st expression $= \frac{15}{28} \times \frac{5}{36} + \frac{425}{432} = \frac{25}{24}\left(\frac{1}{14} + \frac{17}{18}\right) = \frac{200}{189}$.

2nd expression $= \frac{25}{98}$, which is *less* than the 1st expression.

Difference $= \frac{200}{189} - \frac{25}{98} = \frac{25}{7}\left(\frac{8}{27} - \frac{1}{14}\right) = \frac{85}{378}$.

The question has evidently been spoiled either in the making or in the printing. If "added to" be changed to *subtracted from* the answer is $\frac{85}{378}$.

(2) If $x = \cdot075$, $y = \cdot025$, we have $(x^3 \times y^3) \div (x^2 - xy + y^2)$ and this is $= x + y = \cdot075 + \cdot025 = \cdot1$.

(3) $9_{\frac{8}{4}\frac{5}{9}\frac{2}{9}\frac{2}{5}} \times \frac{11}{37} = \frac{458477}{49995} \times \frac{11}{37} = \frac{458477}{4545 \times 37} = \frac{458477}{168165}$

$= 2{\cdot}72635209 + .$

(*b*) $\frac{1}{100}\left(\frac{15}{16} + \frac{84}{5} + \frac{100}{3} - \frac{1}{120}\right) = \frac{1}{100}\left(\frac{12257 - 2}{240}\right) = \frac{817}{1600}$ Ans.

(4) $\frac{95}{100}$ marked price $= \frac{115}{100}$ cost price;

$\therefore$ marked price $= \frac{23}{19}$ cost price; $\frac{23}{19} \times \$3.80 = \$4.60$.

(5) 7 : 5 gives a majority of 2 in 12 votes polled, or $\frac{1}{6}$ of votes;

$240 \times 6 = 1{,}440$; $1{,}800 - 1{,}440 = 360$ not polled.

(6) Length of pathway to be made = 140 + 100 + 60 + 45 = 345 ft.

Price of pathway $= \frac{345 \times 5}{9} \times \frac{5}{8} = \$119.79\frac{1}{6}$.

(7) A's capital : B's capital = 5 : 3 ; ∴ B's gain is $\frac{5}{3}$ A's gain.

Expenses \$140 + \$400 = \$540 ; net gain = \$2,260.
A's share = \$1,250 ; ∴ B's share = \$750 ;
∴ B received \$260 as manager.

(8) If simple interest is meant, interest = \$213.75

∴ $1{,}520 \times 2\frac{1}{4} \times r = 213.75$; ∴ $r = \frac{1}{16} = 6\frac{1}{4}\%$.

(*b*) Interest on \$100 must = \$100 ; ∴ $100 \div 6\frac{2}{3} = 15$ yr.

(9) Let $20x$ = price of a sheep ; ∴ $8{,}000x$ = cost.
150 at $24x$ + 120 at $23x$ + 130 at $18x$ = $8{,}700x$;
gain = $700x$; ∴ $700x$ = \$217, ∴ $100x$ = \$31 ;
$8{,}000x$ = \$2,480.

(10) Price $= \frac{7 \times 30 \times 165 \times 12}{3 \times 5 \times 16} = \$1{,}732.50$.

1877 (Page 86).

(1) $\frac{9}{10}$ of 41 oz. pure silver = 69 thalers

1 oz. pure silver $= \frac{69 \times 10}{9 \times 41}$ thalers.

Also $\frac{37}{40}$ oz. pure siver $= \frac{41}{8}$ shillings

1 oz. " $= \frac{205}{37}$ "

∴ $\frac{69 \times 10}{9 \times 41}$ thalers $= \frac{205}{37}$; 1 thaler = $2s.\ 11\frac{473}{585}d.$

(2) 1st fraction = 12 ; 2nd fraction = 4 ; difference = 8 dy.

B's work per day $= \frac{1}{2} - \frac{1}{8} = \frac{3}{8}$; B's time = $2\frac{2}{3}$ dy.

(3) Waste $= \frac{1}{35}$; $\therefore \frac{34}{35}$ of original quantity = 170 lb.;

original quantity = 175 lb.;

$\frac{33}{112}$, $\frac{55}{112}$, $\frac{24}{112}$ of this are $51\frac{9}{16}$, $85\frac{15}{16}$, and $37\frac{1}{2}$ respectively.

(4) £1 $= \$\frac{40}{9} \times 1.09\frac{3}{4}$

$\therefore$ £$18\frac{1}{4} = \frac{40}{9} \times 1.09\frac{3}{4} \times 18\frac{1}{4} = \$89.02$ nearly.

(5) To insure $\$96\frac{3}{8}$ costs $\$3\frac{1}{3}$

" \$1 " $\$\frac{1}{29}$

" $\$48,628\frac{1}{6}$ costs $\$1,676.83\frac{1}{3}$.

(6) $N = D \times \frac{6}{5}$; $\therefore D \times \frac{11}{5} = 352$; $D = 160$; fraction $= \frac{192}{160}$

(7) No. square yards paper $= 178\frac{2}{7} \times \frac{21}{36} = 104$ sq. yd.

Length of walls $= 2$ (width $+ \frac{7}{6}$ width) $= \frac{13}{3}$ width

$\therefore \frac{13}{3}$ width $\times 4 = 104$; $\therefore$ width $= 6$ yd., length $= 7$ yd.

Cost $6 \times 7 \times \frac{36}{27} \times \frac{7}{4} = \$98$.

(8) L. C. M. = product $\div$ G. C. M. Let x = unknown No.
$\therefore 634,938,944,494 = 85,044,059x \div 9,187$
$\therefore x = (634,938,944,494 \times 9,187) \div 85,044,059 = 68,590,142.$

(9) Interest $= \frac{7}{50}$ principal; discount $= \frac{7}{57}$ principal

$\therefore \left(\frac{7}{50} - \frac{7}{57}\right)$ principal $= \$9.80$; principal $= \$570$.

(10) Breadth$^2 = 2 \times 4,840 + 300 = 9,980$;
$\therefore$ breadth $= 99{\cdot}89 +$ yards; length $= 299{\cdot}69 +$ yards.

1878 (PAGE 87).

(1) Product ÷ G. C. M. = L. C. M.
$\therefore$ 391 No. = 12,121 × 23; No. = 713.

(2) $\frac{361}{130} \times \frac{7}{170} \times \frac{361}{170} = \frac{912247}{3757000}$.

(3) ·9840018 ÷ ·00159982 = 615·070320 + .

(4) Ans. $= \frac{208 \text{ mi. } 181 \text{ ac. } 93 \text{ yd. } 4 \text{ ft.} \times 3 \times 439}{767{\cdot}9 \text{ ac. } 279 \text{ yd. } 4 \text{ ft.}}$

$= \frac{5806592401 \times 3 \times 439}{33452239}$; cancel 439;

$= \frac{1741977203}{76201} = \$228{,}603.$

(5) Let a line a inches long represent the capital, and a line b inches long represent the interest, thus

a | b; $\therefore a + b$ represents the amount.

Now b is the interest on a, and the discount on $a + b$

$\therefore$ interest $= \frac{a}{b}$ of the capital; discount $= \frac{a}{a+b}$ of the debt.

(*b*) $\frac{a}{b}$ capital = 110; $\frac{a}{a+b} = 88$

Divide one equation by the other, and $\frac{ab + a^2}{ab} = \frac{110}{88}$;

$1 + \frac{a}{b} = 1 + \frac{1}{4}$; $\therefore \frac{a}{b} = \frac{1}{4}$. Capital = \$440.

(6) One brick with mortar $= 162 \times \frac{17}{16}$ cub. in.

Wall = 7,050,240 cub. in.

No. bricks $= 7{,}050{,}240 \times \frac{16}{17} \times \frac{1}{162} = 40{,}960$ bricks.

(7) Let $10{,}129 = x$; $\therefore 101{,}293^2 = (10x + 3)^2 = 100x^2 + 60x + 9$
= 10,259,664,100 + etc. = 10,260,271,849.

(8) $\frac{\cdot 047619}{1\cdot 190476} = \frac{47619}{1190476}$. Now $25 \times 47{,}619 = 1{,}190{,}465$,

so that the square root must be a trifle less than $\frac{1}{5}$

(9) Times are as $40 : 60 = 2 : 3$; $\therefore$ rates are as $3 : 2$
1st rate = 3 mi. in 40 min.; $\therefore$ 2nd rate = 2 mi. in 40 min.
$\therefore$ rate of stream = 1 mi. in 40 min.;
$\therefore$ up rate against stream = 1 mi. in 40 min. = 3 mi. in 120 min.
Ans. 2 hr.

(10) $100x$ at 80, gives $\frac{5}{4}x$ stock at $5 = \frac{25}{4}x$, income from 1st.

$150x$ at 120, " $\frac{5}{4}x$ " at $8 = 10x$, " 2nd.

$\therefore \frac{65x}{4} = \$520$; $5x = 160$, $100x = \$3{,}200$, $150x = \$4{,}800$.

1879 (Page 88).

(1) 1st addend $= \frac{5}{2}$; 2nd $= \frac{1}{2}$; 3rd $= \frac{1}{100}$; sum $= \frac{301}{100}$

$\frac{301}{100} \times \frac{31}{9} \times \frac{9}{62}$ of $1{,}400d. = £8\ 15s.\ 7d.$ Ans.

(2) ·03749; ·012602.

(3) ·311768.

$$\text{Expression} = \frac{3\sqrt[3]{\cdot 02} - 23 \times \cdot 125\sqrt[3]{\cdot 02}}{2\sqrt[3]{\cdot 02} + \sqrt[3]{\cdot 02}} = 1 - \cdot 95\dot{8}3 = \cdot 04\dot{1}6$$

(4) Area of whole $= 135 \times 180 = 24{,}300$ sq. ft.
Area of remainder $= 159 \times 114 = 18{,}126$ "
Area of path $6{,}174$ "
Cost $= (6{,}174 \times \cdot 025) + (181\cdot 26 \times \cdot 175) = \$186\cdot 0705$.

(5) $\$693.33 - 640\cdot 805 = \$52\cdot 525$ = interest for $2\frac{1}{2}$ yr.
$\therefore \$21.01 =$ " 1 yr.
$\therefore \$168.08 =$ " 8 yr.
$\$693.33 - 168.08 = \$525.25$ = principal
$\$21.01$ = interest on 525.25, $\therefore$ rate = 4%.

(6) Cost price $= \frac{10}{11}$ of \$2.80 $= \$\frac{28}{11}$

Prices of two kinds of wine $= \$\frac{24}{10}$, and $\$\frac{32}{10}$

Gain on 1st $= \frac{28}{11} - \frac{24}{10} = \$\frac{16}{110}$

Loss on 2nd $= \frac{32}{10} - \frac{28}{11} = \$\frac{72}{110}$

Gain : loss = 16 : 72 = 2 : 9. But gain must = loss
∴ we must have 9 of 1st kind to 2 of 2nd kind to give loss : gain = 18 : 18. Ans. 9 : 2.

(7) Gain on 112 $= 115\frac{3}{4} - 112 + 4 = 7\frac{3}{4}$
∴ " 448 = 31
" 4,480 = 310. Ans. \$4,480.

(8) $20\% = \frac{1}{5}$, $33\frac{1}{3}\% = \frac{1}{3}$. Let 30 and 48 be the capitals.

∴ A's stock $= \begin{cases} 48 \times 6\frac{1}{2} = 195 \text{ for 1 month.} \\ 24 \times 5\frac{1}{2} = 132 \text{ " 1 " } \\ \text{Total } 327 \text{ " 1 " } \end{cases}$

B's stock $= \begin{cases} 48 \times 7\frac{1}{2} = 360 \text{ for 1 month.} \\ 32 \times 4\frac{1}{2} = 144 \text{ " 1 " } \\ \text{Total } 504 \text{ " 1 " } \end{cases}$

Whole stock = 327 + 504 = 831 for 1 month.

A's share of gain $= \frac{327}{831} \times 3{,}047 = \$1{,}199$

B's share of gain $= \frac{504}{831} \times 3{,}047 = \$1{,}848$. Ans.

(9) 75 dy. $= \frac{15}{73}$ yr.; interest at $10\% = \frac{3}{146}$; amount $= \frac{149}{146}$

$\frac{149}{146}$ of 375.80 = \$383·526 = broker's receipts at the end of 75 dy.

135 dy. $= \frac{27}{73}$ yr.; interest at $8\% = \frac{216}{7300}$; ∴ discount $= \frac{216}{7516}$

∴ P. W. $= \frac{7300}{7516}$ of \$383·526 = \$372·504 + . Ans.

(10) Area of end in sq. ft. $= \frac{(13+12\frac{1}{2})(13-12\frac{1}{2})3\frac{1}{7}}{144} = \frac{51 \times 11}{14 \times 144}$

Cost $= \frac{51 \times 11}{14 \times 144} \times 864 \times 3 \times \frac{125}{2} \times \frac{777}{100} \times \frac{351}{20000} = \$6,147{\cdot}315.$

1880 (Page 90).

(2) $18s.\ 4d. + 1s.\ 2\frac{1}{4}d. + 14s.\ 7d. = £1\ 14s.\ 1\frac{1}{4}d.$

(3) Dividing, expression $= 2 + \frac{\sqrt{8}}{\sqrt{8}-\sqrt{7}} = 2 + \frac{8+\sqrt{56}}{8-7}$
$= 10 + 2\sqrt{14} = 10 + 2\,(3{\cdot}7416574) = 17{\cdot}4833148.$

(4) $\frac{36}{1000} \times \frac{55}{900} \times \frac{2000}{32} \times 7{,}000 = 962\frac{1}{2}$ grains.

(5) Face of note = P. W. + True Discount;
Int. on face = int. on P. W. + int. on True Discount,
or Bank Discount = True Discount + int. on True Discount.

(*b*) Discount $= \frac{6}{150} = \frac{1}{25}$ principal; $\therefore$ int. $= \frac{1}{24}$ principal.

For twice the time int. $= \frac{1}{12}$; discount $= \frac{1}{13}$ of \$150 $= \$11.53\frac{1}{13}$.

(6) If A's capital is \$125, B's is \$100 for the 1st year.
And A's capital is \$50, B's is \$60 for the 2nd year.
Capitals are as $175 : 160 = 35 : 32$

A's share $= \frac{35}{67}$ gain, B's $\frac{32}{67}$. Shares \$1,767.50, \$1,616.

(7) If $100x$ = cost of silk, 350 yd. silk cost $35{,}000x$;
1,470 yd. lustre cost $44{,}100x$

$\therefore \frac{1}{3}$ of $44{,}100x$ loss $- \frac{35}{100}$ of $35{,}000x = \$39.20$

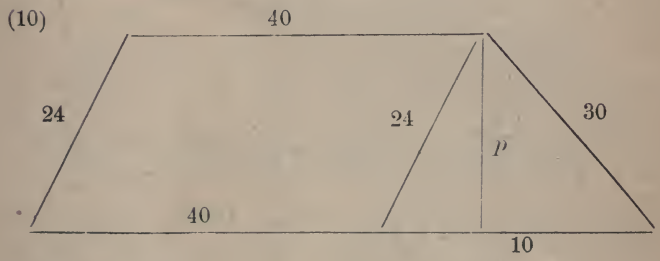
$\therefore 245x = 392c.$; $100x = \$1.60$ per yard.

(8) Tea cost \$4,500; commission on tea \$180;
$\therefore$ commission on flour = \$120; $2\frac{1}{2}\%$.

(9) Carry out the repetends to 8 places to ensure accuracy.

$$\begin{array}{r} 2{\cdot}60000000 \\ 2{\cdot}37000000 \\ 3{\cdot}00666666 \\ 2{\cdot}97571428 \\ 3{\cdot}51651651 \\ \hline 5\overline{)14{\cdot}468897} \\ \hline 2{\cdot}893779 \end{array}$$

(10)



Area of triangle $= \sqrt{(32 \times 8 \times 22 \times 2)} = 5p =$

$\sqrt{(64 \times 16 \times 11)} = 32\sqrt{11}$, $\therefore p = \frac{32}{5}\sqrt{11}$.

1881 (PAGE 91).

(1) L. C. M. $= 5 \times 17 \times 47 \times 109 \times 243 = 105{,}815{,}565$.

(*b*) L. C. M. of $4\frac{1}{2}$, 5, $2\frac{3}{4}$, and $3\frac{1}{2} = 3{,}465$ in. = side of square. ANS.

(3) ANS. $4{,}859\frac{23}{168}$; 5 dy. 21 hr. 11 min. $53\frac{13}{35}$ sec.

(4) Litre = 1 cub. decimetre $= \frac{1}{1000}$ cub. metre.

1 pint $= \frac{277}{8} = 34{\cdot}625$ cub. in.

$\therefore$ 1 litre $= 1{\cdot}76077 \times 34{\cdot}625$ cub. in.
$\therefore$ 1 metre = 10 cube root of $(1{\cdot}76077 \times 34{\cdot}625) =$ 39·37 + inches. ANS.

(5) The ratios are 7 : 6 ; 5 : 6 ; 16 : 9 ; x : 3.

$$\therefore x = \frac{6 \times 6 \times 9 \times 3}{7 \times 5 \times 16} = 1\tfrac{103}{140} \text{ dy.} \quad \text{ANS.}$$

(6) No. men $= \dfrac{9 \times 40 \times 2000^2 \times 1000}{12 \times 30 \times 1600^2} = 1{,}562\frac{1}{2}$ men. ANS.

(7) In 15 min. (true time) the *minute* hand will pass over $\frac{9}{10}$ of 15 minute spaces $= 13\frac{1}{2}$ spaces.

In 15 min. (true time) the *hour* hand will pass over $\frac{21}{20}$ of $\frac{5}{4}$ minute spaces $= 1\frac{5}{16}$ spaces.

Distance apart $= 13\frac{1}{2} - 1\frac{5}{16} = 12\frac{3}{16}$ spaces. ANS.

(8) \$3,700 yields \$270 interest; \$100 yields $7\frac{1}{37}$. ANS.

(9) The company gets compound interest for its money.

$\therefore$ Sum $(1.08)^2 = 70\,(1.08) + 70 + 1{,}000 = 1{,}145.60$

$\therefore$ Sum $= \dfrac{1145.60}{1.08 \times 1.08} =$ \$982.17 nearly. ANS.

1882 (PAGE 92).

(1) Let A be the point in the fore-wheel, and B in the hind-wheel. Now B will be at the top when the carriage has moved on 6, 18, 30, etc. feet, and at 36 ft. A and B will be together at the initial position on the ground. As A is never at the top at 6, 18, or 30 ft., and as the same cycle of figures recurs, the statement is evidently correct.

(2) Fractions $= 1$; ANS. $\dfrac{3}{10000}$.

(4) P. W. $= 320 \div 1.08^2 = 200{,}000 \div (9 \times 9 \times 9) =$ \$274·3484+.

(5) $(1.15)^5 = 2.01 +$. ANS. 5 yr. nearly.

(6) \$1,085 currency $=$ \$1,000 gold $= 5{,}250$ francs;
x francs $=$ \$1,500 currency.
$\therefore x = 5{,}250 \times 1{,}500 \div 1{,}085 = 7{,}258$ francs $6\frac{98}{117}$ centimes.

(7) Apparently the note does not bear interest.
Banker pays $486\frac{2}{3}$, gets back \$500,

$\therefore$ rate $= \dfrac{2}{73} = 8{\cdot}219\%$ nearly.

(8) B's cost + B's gain = \$19

B's cost $-\frac{5}{4}$ B's gain = \$13

$\frac{9}{4}$ B's gain = 6; B's gain = $\$\frac{8}{3}$

$\therefore$ B's cost = $19 - \frac{8}{3}$ = A's selling price = $\frac{49}{3}$

B's gain = 8 on 49 = A's gain = $\frac{8}{49}$ per dollar.

$\therefore \frac{57}{49}$ A's cost = $\$\frac{49}{3}$; A's cost price = \$14.04$\frac{7}{17}$.

(9) Value of mixture = 21 times silver in mixture. Turned into gold, the volume of silver in mixture is worth $\frac{1284}{35}$ times the silver now in the mass; and the gold already present is worth 20 times the silver now in the mass. Hence when whole mass becomes gold its value is $\left(\frac{1284}{35} + 20\right)$ times = $\frac{1984}{35}$ times the silver in the mass. Hence it would be $\frac{1984}{35} \div 21 = 2\frac{214}{735}$ times more valuable.

(10) $4 \cdot 1888 = \frac{4}{3}$ of $3 \cdot 1416 = \frac{4}{3}\pi$. Let r = req'd radius of circle. Then $\frac{4}{3}\pi r^3$ is given = 1,728 cub. in. to find πr^2, the area of circle.

$\therefore r^3 = 1{,}728 \div \frac{4}{3}\pi = 36 \times 36 \div \pi$; $\therefore r = 6\sqrt[3]{6} \div \sqrt[3]{\pi}$

$\therefore \pi r^2 = 36\sqrt[3]{36\pi} = 36\sqrt[3]{36} \times 3 \cdot 1416 = 216\sqrt[3]{\cdot 5236}$
$= 216 \times \cdot 80599 = 174 \cdot 09384 +$ square inches.

1883 (Page 93).

(1) $\frac{1}{7}$ of £39 = £5 11*s*. 5$\frac{1}{7}$*d*.; $\frac{1}{14}$ of £2 12*s*. = 3*s*. 8$\frac{4}{7}$*d*.;

$\frac{1}{7}$ of 45*d*. = 6$\frac{3}{7}$*d*.; sum = £5 15*s*. 8$\frac{1}{7}$*d*.

(*b*) $13\frac{3}{8} \div 19\frac{1}{2} = 107 \div (12 \times 13) = \cdot 6858974\dot{3}$.

(2) The price of 8,596 lb. at £10 18*s.* 7½*d.* ÷ 10,000 = Ans.

		£8,596	0*s.*	0*d.*	= price at	£1	0*s.*	0*d.*
				10				
10*s.* =	£½	85,960	0	0	= "	£10	0	0
4s. =	⅕	4,298	0	0	= "		10	0
6*d.* =	⅛	1,719	4	0	= "		8	0
		1,719	4	0				
1½*d.* =	¼	214	18	0	= "			6
		53	14	6	= "			1½
		£93,965	0	6	= "	£10	18	7½

∴ price of ·8596 lb. = 9·3965 + ·0000025 = £9 7*s.* 11·1606*d.* Ans.

(3) Interest on \$500 for 75 dy. = \$10.20
Interest on \$100 for 365 dy. = \$10.20 = $10\frac{1}{5}\%$.

(4) 7 on 95, and 7 on 100 = $\frac{7}{95}$ and $\frac{7}{100}$ on \$1 invested;

difference = $7\left(\frac{1}{95} - \frac{1}{110}\right) = \frac{21}{19 \times 110}$ = loss on $\frac{7}{95}$ income

∴ loss on \$100 income = $13\frac{7}{11}$. Ans. $13\frac{7}{11}\%$.

[N.B.—It is *barely possible* that the examiner meant by the question, "How much less per cent. did he make on his investment?" If so we should say 7 on 95 is $\frac{7}{19}$ on 5, or $7\frac{7}{19}$ on 100, rate = $7\frac{7}{19}\%$ on 1st chance; 7 on 110 is $\frac{7}{11}$ on 10, or $6\frac{4}{11}$ on 100, rate = $6\frac{4}{11}\%$ on 2nd chance. Difference of rate per cent. on investments = $7\frac{7}{19} - 6\frac{4}{11} = \frac{140}{19} - \frac{140}{22} = 140\left(\frac{1}{19} - \frac{1}{22}\right) = \frac{140 \times 3}{19 \times 22} = \frac{210}{209} = 1\frac{1}{209}\%$, If he did mean this he deserved severe censure for ambiguity.]

(5) 5 gold + 9 silver + 11 bronze = 4 gold + 15 silver + 10 bronze
$\therefore$ 1 gold + 1 bronze = 6 silver. Now this relation will be satisfied if we count 1 point for bronze, 2 for silver and 11 for gold; 1 point for bronze, 3 for silver and 17 for gold; 1 point for bronze, 4 for silver and 23 for gold, etc., etc., indefinitely.

(6) $20s. + 3(21s.) + 6(13\frac{1}{3}s.) = 163s.$
$815 \times 20 \div 163 = 100$ sov.; 300 guineas; 600 marks.

(7) $60° = \frac{1}{6}$ circle = 10 min.;
space to be gained = 20 min.; time $2 \cdot 21\frac{8}{11}$ min.

(8) $\left(\frac{3}{2}\text{ of }\frac{3}{2}\text{ of }\frac{3}{2}\right)$ population = 2,700; population = 800.

(9) In 400 yr. there are 97 leap and 303 common years;
$\therefore$ average length = $[(97 \times 366) + (303 \times 365)] \div 400 =$ 365·2425 dy. = 365 dy. 5 hr. 49 min. 12 sec.

(10) 1st cube contains No. pounds Troy + No. pounds Avoir.
$= \frac{144}{175}$ No. Avoir. + No. Avoir. $= \frac{319}{175}$ No. Avoir.
2nd cube contains No. lbs. Avoir. + No. Avoir. $= \frac{350}{175}$ No. Avoir.
$\therefore$ Weights, *i.e.* volumes, are 319 : 350;
$\therefore$ sides are as $\sqrt[3]{319} : \sqrt[3]{350}$; or as 6·832771 : 7·047298.

1884 (Page 93).

(1) $\frac{17}{1650}$.

(2) $8s. \ 9d.$

(3) Powers are as 4 : 5; times as 3 : 4, hence work done is as 12 : 20, or as 3 to 5. Ans. $\$22\frac{1}{2}$, $\$37\frac{1}{2}$.

(4) $101\% = 101$ half-pence; $99\% = 99$ half-pence. Ans. $4s. \ 1\frac{1}{2}d.$

(5) Rates are as 3 : 1; times as 1 : 3; actual time is $405\frac{5}{11}$ min.
$\therefore$ distance = $\frac{1}{4}$ time at $8\frac{1}{4} = 13\frac{1}{16}\frac{5}{8}$ min.

(6) Loss = 35 on every 3,625 sold, etc. Ans. $= \frac{700}{727}\%$.

(7) $\$4.96 = \frac{102}{100}$ par, etc. Ans. $\$4.86\frac{2}{3}$.

(8) $\frac{37}{40}$ weight in ounces $\times$ 1,700 + $\frac{3}{40}$ weight $\times$ 110 = 1,000c.
Number ounces = 4,000 ÷ 6,323.

(9) Length : length = 1 : 14; weight : weight = 77 : 89.
∴ weight of copper rod : weight of iron rod = 11 : 178;
$\frac{178}{11}$ of $\frac{319}{10}$ = 516·2 oz. Ans.

(10) $\$52.80 - 46.20 = 6.60$; $52.80 \div 6.60 = 8$ yd. Ans.

(*b*) The thickness has become $\frac{27}{16}$ of what it was,
hence the breadth must be made $\frac{16}{27}$ of what it was;
decrease = $\frac{11}{27}$ breadth = $\frac{11}{27}$ of 42 in. = $17\frac{1}{9}$ in. Ans.

1885 (Page 94).

(2) $211\frac{1}{2}$ yd. cost $\$810.43\frac{3}{4}$.
∴ selling price per yard = $\$810.43\frac{3}{4} \times \frac{6}{5} \div 211\frac{1}{2} = \$4.59\frac{11}{141}$.

(3) $55s. + 2s. 3d. + 1_{\frac{5}{38}}d. = £2\ 17s.\ 4_{\frac{5}{38}}d.$

(4) Average price = ·845 per bushel, at which 110 bush. give $92.95. This is $2 less than the real price. Now the difference must be made up by taking more at the higher price; $2 ÷ ·25 = 8 bush. more. 55 + 8, 55 − 8; the quantities are 63 and 47.

(5) $120 = 60 yd. cloth; $96 = 48 yd. cloth. Suppose an increase in the cloth instead of an advance in price. Say he buys x yards at $2, sells $(x + 60)$ yd. at $2, or $(x - 48)$ at $2.
The loss in the supposed case = 108 yd. = $\frac{1}{5}(x + 60)$; $x = 480$ yd.

(6) $100 on policy costs $\$\frac{7}{8}$ premium; net proceeds = $\$99\frac{1}{8}$.
∴ premium = $\frac{7}{793}$ of proceeds = $\frac{7}{793}$ of 47,580 = $420.

(7) Interests $\frac{42}{1600}$, $\frac{45}{1600}$, $\frac{54}{1600}$, $\therefore$ 14A's = 15B's = 18C's.
$\therefore$ A : B : C = 45 : 42 : 35. Divide sum by 122, etc.
A's share = \$1,822.50; B's \$1,701; C's \$1,417.50.

(8) $90 + 3 = 93$ dy. $= 3\frac{1}{10}$ mo. Int. $= \frac{31}{800}$; proceeds $= \frac{769}{800}$ face
$\therefore$ face of note = \$884·2652 . . . .

(9) Gains are as 29 : 39; A's capital $\frac{29}{68}$, B's $\frac{39}{68}$ of total.
$\therefore \frac{39}{68}$ capital = 78,000 for 1 mo., $\therefore$ A's capital = 58,000 for 1 mo.
He withdrew 14,000 for 1 mo. = \$2,000 for the 7 mo.

(10) (Ladder)^2 = (wall)$^2 + 10^2$ = (wall $- 2$)$^2 + 14^2$. Euc. I. 47.
Wall = 25 ft.; ladder $\sqrt{725} = 26{\cdot}925824$ ft.

1886 (Page 95).

(1) A's = C's $-$ 17, B's = C's $-$ 10, C's = C's;
A gives 12 to B and 5 to C, and C has \$46 more than A.

(2) $\frac{1}{4} + \frac{2}{3} = \frac{11}{12}$, $\therefore$ 1 hr. $= \frac{1}{12}$ of time, time = 12 hr.
3 hr. at 14 + 8 hr. at 25 + 1 hr. at 7 = 249 mi.

(3) At 4 o'clock, minute hand is 20 spaces behind, gain 22 spaces $= \frac{11}{12}$ of time required since minute hand gains 11 spaces out of every 12 it moves. Time $= \frac{12}{11} \times 22 = 24$ min. past 5 o'clock.

(4) Wages are as 5 : 1; rates as 2 : 1; times as $\frac{5}{2}$: 1,
or as 5 : 2; *i.e.* boy's time $= \frac{2}{5}$ man's time $= \frac{2}{5}$ of 15 = 6.
Hence man alone takes 15 + 6 = 21 hr.

N.B.—The words "in proportion to, etc.," are so placed as to be capable of several interpretations. The problems lacks precision of statement.

(5) The 28 gal. cost \$13; quantity sold at 60c. per gallon gives \$18, $\therefore$ quantity = 30 gal. Ans. 2 gal.

(6) 75 marks for the last three questions; to be divided as 3 : 5 · 7. Ans. 15, 25, 35 marks.

(7) 35c. $-$ 35% discount = $22\frac{3}{4}$c.

(8) Discount $= 253.03 \times \frac{9}{100} \times \frac{82}{365} = \$5.19$, add 45c. $= \$5.64$.
$\$253.03 - 5.64 = \$247.39$.

(9) Cubic feet in the cistern $= \frac{22}{7} \times \left(\frac{5}{2}\right)^2 \times 4 = \frac{550}{7}$ cub. ft.

No. gallons $= \frac{550}{7} \times 62{\cdot}426 \times \frac{1}{10} = 490{\cdot}49$ gal.

1887 (Page 96).

(1) Multiply N and D by 4, and remove inner brackets

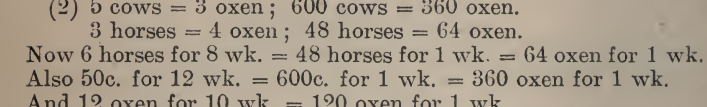
$$\frac{(29 - 14) \times (4\frac{2}{10} - 2\frac{1}{3} + 1\frac{7}{10})}{(29 + 14) \div \left(1\frac{1}{2} - 9\frac{1}{2} \times \frac{9}{77}\right)} = \frac{15 \times \frac{107}{30}}{43 \div \frac{60}{154}} = \frac{1605}{3311}.$$

(2) 5 cows $= 3$ oxen; 600 cows $= 360$ oxen.
3 horses $= 4$ oxen; 48 horses $= 64$ oxen.
Now 6 horses for 8 wk. $= 48$ horses for 1 wk. $= 64$ oxen for 1 wk.
Also 50c. for 12 wk. $= 600$c. for 1 wk. $= 360$ oxen for 1 wk.
And 12 oxen for 10 wk. $= 120$ oxen for 1 wk.
Hence the shares are as $64 : 120 : 360$; or $8 : 15 : 45$

$\therefore$ A's share $= \frac{9}{88}$ or $\frac{2}{17}$ of $\$92 = \$10\frac{14}{17}$ which leaves
$\$81\frac{3}{17}$ to be paid to B and C, whose shares are as $1 : 3$.

B $\frac{1}{4}$ of $\$81\frac{3}{17} = \$20\frac{5}{17}$; C $\frac{3}{4}$ of $\$81\frac{3}{17} = \$60\frac{15}{17}$.

(3) Represent the time each worked by three lines.



Thus C works alone $2\frac{3}{5}$ dy., B and C together $\frac{4}{5}$ dy., and
A, B and C together the remainder of the time.
C does $\frac{13}{60}$ work, B and C $\frac{7}{45}$ work; leaving $\frac{113}{180}$ to be done
by A, B, C together at $\frac{53}{180}$ per day; time required $= 2\frac{7}{3}$ dy.

$\therefore$ whole time $= 2\frac{7}{3} + 3\frac{2}{5} = 5\frac{14}{15}$ dy.

(4) ·007916.

(5) Bank interest = \$15 : interest on \$860 for 1 dy. =

$$\frac{1}{360} \times \frac{8}{100} \times 860 = \frac{43}{225}$$

No. days $= 15 \times \frac{225}{43} = 78\frac{3}{43}$ or 79 dy.

Subtract 3 dy. grace; 76 dy. from March 23rd is June 7th.

(6)

£87	17	11	×	184	=	£16,172	16	8	
4	7	$10\frac{3}{4}$	×	17	=	74	14	$2\frac{3}{4}$	
1	1	$11\frac{1}{16}$	×	$3\frac{1}{2}$	=	3	16	$10\frac{39}{37}$	
				Total price	=	£16,251	7	$9\frac{21}{32}$.	

(7) \$75 invested yields \$4 per yr.; \$75 sold out gives \$20 profit; \$75 at $7\frac{1}{2}\% = \frac{45}{8}$ per year. Hence the equation :—

(\$4 × No. years) + \$20 = $\$\frac{45}{8}$ × No. years; No. years $= 12\frac{4}{13}$.

Otherwise :—\$20 = $2\frac{1}{6}\%$ on \$75 for x years, $\therefore x = 12\frac{4}{13}$.

(8) Water $= \frac{7}{93}$ of the vinegar; it must be made $= \frac{2}{23}$ of the vinegar; amount to be added $= \left(\frac{2}{23} - \frac{7}{93}\right)$ of the vinegar $= \frac{25}{23 \times 93}$

$\frac{25 \times 93}{23 \times 93} = 1\frac{2}{23}$ gal. to be added to the water.

(9) Loss to be retrieved = \$2,000; \$8,000 at 8% = \$640; \$1,360 to be made up by gain of 4% on borrowed money; $\therefore$ sum = \$34,000.

N.B.—This is a *viciously vague* problem. Insert "at par" after \$10,000; "at once" after "sold out," "per annum" after per cent.

(10) 2 (side)^2 = (diagonal)^2, Euc. I. 47; side = $\sqrt{}$area

$\therefore$ side = square root of $\left(\frac{55}{2} \times 4840\right) = 110\sqrt{11}$; diag. $= 220\sqrt{11}$.

(11) ·3% $= \frac{3}{1000}$; so that if the side were 1,000 at first, it would be 1,003 after expansion; $\therefore$ cubical content increases from $1{,}000^3$ to $1{,}003^3$; increase = 9,027,027 on 1,000,000,000, or ·9027027 per hundred.

(12) 1 in. deep of reservoir contains $187 \times 96 \times 9 \times 144$ cub. in.

Area of section of pipe $= \frac{22}{7} \times 7^2 = 7 \times 22$ sq. in.

10 mi. per hour $= 10 \times 5{,}280 \times 12 \div 60 = 5{,}280 \times 2$ in. per minute.

No. minutes required $= \frac{187 \times 96 \times 9 \times 144}{7 \times 22 \times 5{,}280 \times 2} = 14{\cdot}3064$ min.

1888 (Page 97).

(1) $N = \frac{5}{16} - \frac{11}{96} = \frac{19}{96}$; $D = 4\frac{1}{2} - 3\frac{1}{2} - 4\frac{2}{7} + 3\frac{7}{8} + \frac{3}{56}$

$= \frac{1}{2} - \frac{1}{3} - \frac{2}{7} + \frac{7}{8} + \frac{3}{56} = \frac{17}{21}$

Fraction $= \frac{19}{96} \times \frac{21}{17} = \frac{113}{544}$.

(*b*) $365\frac{1}{4}$ dy. = 31,557,600 sec.; 349 dy., etc. = $30{,}185{,}520\frac{1}{2}\frac{1}{3}$ sec.
Required fraction = $694{,}266{,}970 \div (31{,}557{,}600 \times 23)$.

(2) A does 1 piece in x days, B in $2x$ days, C in $3x$ days.
∴ A does 6 pieces, B does 3 pieces, C 2 pieces in $6x$ days each.
∴ A, B, C do 11 pieces in $6x$ days; ∴ $6x = 11 \times 18$, $x = 33$.
The times are 33, 66, 99 dy.

(3) P. W. of note = \$1,360 − 20.40 = \$1,339.60
Total cost of lot = \$1,200 + 72 = 1,272.00. Ans. \$67.60.

(4) Sold $\frac{2}{5}$ at \$120; $\frac{3}{5}$ at \$217.80 per acre;

average price = \$178.68;
average gain per acre = \$178.68 − \$80 = \$98.68.

78 ac.	at	\$98.68	= \$7,697.04
2 rd.	"	"	= 49.34
1 rd.	"	"	= 24.67
10 per.	"	"	= 6·1675
5 per.	"	"	= 3·0838
7 yd.	"	"	= ·1427
$1\frac{1}{16}$ ft.	"	"	= ·0024
Gain			= \$7,780·4464 +

(5) 6 men earn \$13.50; 7 women earn \$10.50; difference = \$3. The women in the actual case therefore earned \$3 more than the men. \$93 − 3 = \$90; ∴ \$90 ÷ 2 = \$45 = wages of men; 20 men.
∴ \$48 = wages of women; 32 women.

(6) 500 bbl. at \$7 = \$3,500; 4% off leaves \$3,360 to be divided. Let 100 represent the quality of B's flour, ∴ 110 : 100 : 116, *i.e.* $\frac{11}{10} : 1 : \frac{29}{25}$ will represent the flour reduced to B's standard. In barrels this is A, 137½; B, 150; C, 261 barrels of standard quality. Hence divide \$3,360 in the proportion 275 : 300 : 522, and the shares are, A \$842.30, B \$918.87, C \$1,598.83.

(7) Let W and W_2 be the weights of tin and of lead.

∴ $\frac{W_1}{7{\cdot}44}$ and $\frac{W_2}{11{\cdot}35}$ will be the weights of the equal volumes or bulks of water. Also $W_1 + W_2$ = weight of the compound and

∴ $\frac{W_1 + W_2}{10{\cdot}43}$ = weight of an equal volume or bulk of water.

∴ $\frac{W_1}{744} + \frac{W_2}{1135} = \frac{W_1 + W_2}{1043}$. From this $\frac{W_1}{W_2} = \frac{2976}{14755}$ which is the proportion of the weight of tin to lead in the compound.

∴ $\frac{2976}{17731}$ of 765 = tin = 128·39884 + ; lead = remainder.

(8) $\frac{81\frac{1}{4}}{100}$ debt = \$7,950; ∴ debt = $\frac{318 \times 400}{13}$

$\frac{3}{5}$ at 17½ discount = $\frac{3}{5} \times 7{,}950 \times \frac{33}{40} = \frac{318 \times 99}{8}$ = 1st sale.

$\frac{2}{5}$ at 23¾ discount = $\frac{2}{5} \times 7{,}950 \times \frac{61}{80} = \frac{318 \times 61}{8}$ = 2nd sale.

Proceeds = $\frac{318 \times 160}{8} = 318 \times 20$

$318 \times 20 \times \frac{13}{318 \times 400}$ = 65c. on the \$.

(9) The capitals are as 4 : 3 : 2
The times " 4 : 3 : 2
∴ the gains " 16 : 9 : 4; or $\frac{16}{29}, \frac{9}{29}, \frac{4}{29}$.

Length of walls = 90 ft.; area = 90 × 12 sq. ft.

(10) Area of 1 yd. paper $= 6\frac{1}{4}$ sq. ft.; No. yards $= 160$; cost $= 7$c.

(11) Area of surface $= 2 \times \frac{22}{7} \times \frac{5}{4} \times 12$ sq. ft. Cost $= \$117.85$.

(12) Square field $= 77{\cdot}841$ sq. yd.; side $= 279$ yd.;
length of path $= 1{,}132$ yd.; area of path $= 4{,}528$ sq. yd.

1889 (Page 98).

(1) $\frac{1}{10} + \frac{1}{12} = \frac{11}{60}$.

(*b*) Sum $= 81{\cdot}499$; average $= 10{\cdot}1873$.

(2) \$24,944.10 in 380 dy. gains 2,596.92

$\therefore$ rate per cent. per annum $= \frac{2{,}596.92 \times 365 \times 100}{24{,}944 \times 380} = 10\%$.

(*b*) $30{,}441 \times \frac{\text{No.}}{365} \times \frac{1}{10} = 2{,}210.10$; No. $= 265$ dy.

(3) Premium, \$86.80; taxes, \$186.75;
repairs, \$346.45; total, \$620.
Receipts, \$1,860; net income, \$1,240; rate, 8% on cost.

(4) If $4x$ = length, $3x$ = breadth, $12x^2$ = area.
$\therefore 12x^2 = 2{,}523$ sq. per.; $2x = \sqrt{841} = 29$;
$x = 14\frac{1}{2}$ per Ans. 29 per.

(5) June 1 to Oct. 4 $= 126$ dy.; Aug. 15 to Oct. 4 $= 50$ dy.
Interest on note $= \$51.45$; discount $= \$27.23$;
Proceeds $= \$2{,}474.22$.

(6) Let $4x$ = cost of house; $15x$ = cost of farm.
Then $\frac{9}{10} \times 4x + \frac{15}{14} \times 15x = \$3{,}993.30$; $x = 203$.
Ans. \$3,045, \$812.

(7) The No. of yards of cloth becomes $\frac{19}{20}$ of original length

$\therefore$ the price per yard of cloth becomes $\frac{20}{19}$ to clear cost price

$\therefore$ " " " " $\frac{20}{19} \times \frac{6}{5} \times 5.70$

$= \$7.20$ to gain 20%.

(8) Suppose $36x$ = A's capital, then $60x$ = B's
$\therefore$ A's investment = $180x + 189x = 369x$;
B's = $540x + 120x = 660x$
Shares are as 123 : 220; *i.e.* A, \$1,514.13; B, \$2,708.20.

(9) In 2nd case 104 yields \$6, or 78 yields \$4.50; loss 50c. on every share sold; No. shares = $385 \div \cdot 5 = 770$. ANS. \$77,000.

(10) Total cost = \$2,220; selling price = \$2,512, of which the owner pays \$75.36 + 83.44 = \$158.80.
$\therefore$ \$2,220 gains \$133.20; rate 6%.

(11) Cubic inch of lumber =
$(30 \times 44 \times 94) - (28 \times 42 \times 92) = 15{,}888$ cub. in.
Since the boards are 1 in. thick, there are 15,888 sq. in. of lumber.
$\therefore$ cost = $15{,}888 \div (144 \times 50) = \$2.20\frac{3}{3}$.

(12) Cubic inch taken out = $8 \times 30 \times 462$

1 in. deep of cistern contains $\frac{22}{7} \times 42^2$ cub. in.

Cistern is lowered $(240 \times 462) \div \left(\frac{22}{7} \times 42^2\right) = 20$ in.

1890 (PAGE 100).

(1) 10,080; 110,250.

(2) £3 13*s.* 4*d.* + 4*s.* 9*d.* + £2 18*s.* 5*d.* = £6 16*s.* 5*d.*

(3) $133\frac{1}{3}$ lb. = $133\frac{1}{3} \times \frac{144}{175} \times 16 = 1{,}755\frac{3}{7}$ oz. Avoir.

$\therefore$ $6{,}144 \div 1{,}755\frac{3}{7} = 3\frac{1}{2}$ sovereigns.

(4) $\frac{1}{6} + \frac{1}{7} + \frac{1}{9} = \frac{53}{126}$ of a day's work *lost*; $\frac{1}{8} + \frac{1}{10} = \frac{9}{40}$ *gained*

Net loss = $\frac{493}{2520}$; leaving $16\frac{1}{6}\frac{3}{0}$ dy. lost;

$\frac{17}{30}$ less for 17 men. ANS. $\frac{1}{30}$ less.

(5) One brick = $\frac{3}{32}$ cub. ft.; brick + mortar = $\frac{17}{16} \times \frac{3}{32}$ cub. ft.

ANS. $(45 \times 17 \times 4 \times 32 \times 16) \div 3 \times 17 = 30{,}720$ bricks.

(6) 12 ac. $= 58{,}080$ yd. $= \frac{22}{7}(r + r_1)(r - r_1) = \frac{22}{7}(r + r_1)\,22$

$\therefore r + r_1 = 840$, and $r - r_1 = 22$, $\therefore 2r_1 = 818$.

(7) 1,100 sq. ft. of wall; $\therefore \frac{24}{25} \times 1{,}100 \times 2 = 234\frac{8}{9}$ yd.

(8) When pressures are as 2 : 3, volume of air is as 3 : 2

i.e. volume becomes $\frac{1}{3}$ less; $\frac{1}{3}$ volume $= 2$ in. ANS. 6 in.

(9) First income $= 200 \times 5 = 1{,}000$

Second income $= 200 \times 170 \times \frac{100}{108} \times \frac{7}{200} = \$1{,}101.85\frac{5}{7}$

Difference $= \$101.85\frac{5}{7}$.

(10) Cash value of \$5.70 due in 4 mo. at 4%, with $6\frac{2}{3}$% added

$= 570 \times \frac{75}{76} \times \frac{16}{15} = \$6.$

Hence 12c. is the interest on \$6 for required time, *i.e.* 6 mo.

(11) Direct exchange, \$4,150.

Circuitous exchange, $10{,}000 \times \frac{4}{45} \times \frac{40}{9} \times \frac{436}{400} \times \frac{395}{400}$

$= \$4{,}262.09\frac{71}{81}$. $\$112.09\frac{71}{81} =$ difference.

(12) *Dr.* 950 × 0 = 0 for 1 dy. after July 10th.
300 × 50 = 15,000 " " "
250 × 101 = 25,250 " " "
150 × 83 = 12,450 " " "
\$1,650 and \$52,700;
= \$1,650 due in 32 dy. after July 10th, or Aug. 11th.

Cr. 450 × 0 = 0 for 1 dy. after July 10th.
350 × 36 = 12,600 " " "
200 × 57 = 11,400 " " "
\$1,000 \$24,000;
= \$1,000 paid 24 dy. after July, 10th or Aug. 3rd.

Difference 650 due in $\frac{1000 \times 8}{650} = 12$ dy. after Aug. 11th,

i.e. Aug. 23rd.

1891 (PAGE 101).

(2) Policy $= \frac{2}{3}$ of \$7,500 = 50 hundreds; rate $= \frac{9}{5}\%$

$\therefore$ premium $= 50 \times \frac{9}{5} =$ \$90.

(3) Taxable income = \$700; tax = \$1.05.

(4) Take \$100 worth at list price, \$80; \$72 = bill;
72 − 3.60 = \$68.40 invested; \$90 = selling price;
90 − 68.40 = 21.60 gain on \$68.40;
gain on \$100 = $31\frac{11}{19}$. ANS.

(5) Proceeds = (12,000 ÷ 75) × 80 = \$12,800.

1st partial income $= \left(\frac{1}{3} \text{ of } 12{,}800 \div 96\right) \times 3\frac{1}{2} = 155\frac{5}{9}$

2nd partial income $= \frac{2}{3}$ of 12,800 × 5 $= 426\frac{6}{9}$

2nd income $= \overline{582\frac{2}{9}}$

1st income = (12,000 ÷ 75) × 3 = 480

Difference $= \overline{\$102\frac{2}{9}}$.

(6) $1 = 1$; $1{\cdot}04 = 1{\cdot}04$; $1{\cdot}04^2 = 1{\cdot}0816$; $1{\cdot}04^3 = 1{\cdot}124864$;
$1{\cdot}04^4 = 1{\cdot}16985856$.
Sum = 5·41632256, which × 350 = \$1895·712896. ANS.

(7) P. W. of debt $= \frac{400}{1.05} + \frac{300}{1.05^2} + \frac{200}{1.05^3} = \frac{441 + 315 + 200}{1.05^3}$

$956 \times \frac{20}{21} \times \frac{20}{21} \times \frac{20}{21} = 7{,}648{,}000 \div 90{,}261 =$ \$825.83 nearly.

(8) Area = 84, $\therefore$ 168 ÷ 13; ÷ 14; ÷ 15 = perps. $12\frac{3}{13}$, 12, $9\frac{1}{15}$ ft.

(9) Area of lid and bottom = 144; sides = 123,
ends = $107\frac{1}{18}$ sq. ft.; total external area = $374\frac{1}{18}$ sq. ft.
Capacity = (82 × 94 × 106) ÷ 1,728 = $472\frac{79}{216}$ cub. ft.

(10) External diameter of wall = 84 in.; internal = 70 in.

Area of top of wall $= \frac{22}{7} \times \frac{1}{4}(84 + 70)(84 - 70) = 22 \times 77$ sq. in.

Solidity of wall = (22 × 77 × 28 × 12) ÷ 1,728 $= \frac{1}{18} \times 77 \times 77$ cub. ft.

But 1 cub. in. weighs $\frac{2}{3}$ oz.; 1 cub. ft. weighs 72 lb.

Weight of wall $= \frac{1}{18}(77 \times 77 \times 72) \div 2{,}240 = 10\frac{47}{80}$ long tons.

(11) The account can be written out with the following figures:
Freight, \$175 + feed, \$71.78 + commission, \$81.58
+ cash, \$5,234.14 = \$5,562.50.
Sales, \$1,312.50 + \$3,150 + \$1,100 = \$5,562.50.

(12) $10 \div 3 = 3\frac{1}{3}$ bottles each at \$3 a piece; B pays \$4.

1892 (Page 103).

(2) (*a*) $\frac{1}{100}(1 - \cdot03 + \cdot0006 - \cdot00001 + \cdot00000015)$
$= \cdot0097059015.$

(*b*) Arrange each set in groups:—
A = 11 (1·2·3) 12 (1·2·3) 13 (1·2·3)
B = 14 (1·2) 15 (1·2) 16 (1·2) 17 (1·2) 9 (1·2) 19 (1·2) 20 (1·2)
C = 21 . 23 . 25 . 27 . 29. Reducing these we get
A = $11 . 12 . 13 . 2^3 . 3^3$; B = $14 . 15 . 16 . 17 . 9 . 19 . 20 . 2^7$;
and C = $23 . 29 . 7 . 3^4 . 5^2$. And again
A = $11 . 13 . 2^5 . 3^4$; B = $7 . 17 . 19 . 2^{14} . 3^3 . 5^2$, etc., etc.
Fraction = $2^6 . 3^2 . 5 . 7 . 11^3 . 13^3 . 17^2 . 19^2 . 23 . 29 . 31 . 37$.

(3) Length of regiment = 247 yd.; to which add 3 mi. 44 yd., and 3 mi. 343 yd. is distance travelled to clear bridge
$\therefore$ length of step = $(5{,}513 \times 3) \div (56\frac{1}{6} \times 96) = 3\frac{5}{5}\frac{4}{3}\frac{3}{9}\frac{3}{2}$ ft.

(4) Cost = \$750; risk = \$825 + $\frac{3}{400}$ risk. Ans. \$831·234+.

(5) Let x = amount; $\therefore \frac{4\frac{1}{2}x}{101\frac{1}{4}} - \frac{1\frac{3}{8}x}{32\frac{1}{4}} = 31\frac{1}{2}$. x = \$17,415.

(6) Interest = \$165; int. on \$2,417.50 for 1 yr. = \$163·18125
$\therefore$ time required = 1 yr. + $\frac{\cdot181875 \times 365}{163\cdot18125}$ = 1 yr. 4 dy. +
Ans. Jan. 5th or 6th, 1891.

(7) P. W. = $\frac{250}{1\cdot02} + \frac{250}{1\cdot02^2} + \frac{250}{1\cdot02^3} + \frac{250}{1\cdot02^4}$
$= \frac{250}{1\cdot02^4}(1\cdot02^1 + 1\cdot02^2 + 1\cdot02 + 1)$ = etc. = \$951·932 +.

(8) \$5,000 = 26,041⅔ francs; 25,211⅔ francs = 11,345¼ florins;
10,845¼ florins = 18,075$\frac{5}{12}$ shillings = £903 15*s.* 5*d.*
Ans. \$3,975.70.

(9) (*a*) Area $= \sqrt{(60 \times 4 \times 21 \times 25)} = 4 \times 5 \times 7 \times 3 = 420$

(*b*) Area $= (C_1^2 - C_2^2) \div 4\pi$

$= (280^2 - 210^2) \div 4 \times 3{\cdot}1459$
$= (140^2 - 105^2) \div 3{\cdot}14159 = 11{\cdot}1408 + .$

(10) (*a*) Slant height $= 2$; conical surface $= 4\pi \times \frac{2\pi}{4\pi} = 2\pi$;

base $= \pi$; total surface of cone $= 3\pi$;

surface of sphere $= \frac{3}{2}\pi$, $\therefore 4\pi r^2 = \frac{3}{2}\pi$;

$r = \sqrt{\frac{3}{8}}$; volume of sphere $= \frac{4}{3}\pi r^2 = {\cdot}962.$

(*b*) Circumferences are as 45 : 56; large wheel gains 11 in going 56

Small wheel gains $\frac{11}{45}$ of a revolution for every revolution of large wheel

Small wheel gains 1 revolution for every $\frac{45}{11}$ revolution of large wheel

Small wheel gains 12 revolutions for every $\frac{45}{11} \times 12$ revolutions of large wheel

Small wheel gains 12 revolutions every

$$\frac{45}{11} \times 12 \times \frac{22}{7} \times \frac{56}{12} \text{ ft.} = 720 \text{ ft.}$$

Problems in Arithmetic for Junior Classes.

By W. E. GROVES, Principal Church St. School, Toronto. Mainly adapted for the use of pupils in Second and Third Book Classes in public schools. Part I., Second Book Classes. Part II., Third Book Classes. Price 25 cents.

THIS is a volume of over 1100 practical problems, covering the work prescribed for the Second and Third Book Classes. In its preparation the wants of the hard-worked teacher were kept prominently in view.

The following are a few of the reasons why such a book should be in the hands of the pupils :—

1. While the special teachers' edition has all the answers prepared and a great deal of useful matter not usually found in works on arithmetic, the scholars' edition contains only the bare problems. Perfect independence of thought is thus secured in the solving of problems by the pupils.

2. It saves time for the teacher that he would otherwise have to spend in looking for problems or in the manufacture of original ones.

3. It saves to the school the time that the teacher would require in the dictation of problems to the pupils, while from the little hand-book an exercise can be assigned with scarcely a moment's delay.

4. It saves to the pupil the time occupied in copying the problems assigned, leaving him that amount of time to devote to the solutions.

5. It prevents the ruin of a pupil's style of writing from the mad racing pace at which pupils are frequently required to write in the copying of home or class exercises. There is nothing that teachers can do that so successfully destroys all chance of a boy's or girl's learning to write well as the incessant copying of exercises and notes, in order to save the purchase of a fifteen or twenty-five cent book. All your teaching of writing is so much lost time if pupils are allowed to neglect their writing caution when copying other work. Every case where a pupil has to write at all should be made a writing lesson.

6. School Trustees would do well to supply a copy free to each pupil, as the price would soon be saved in the increased time the teacher could give to his classes.

7. There is no other book published where teachers can get copies of the Uniform Promotion Papers set in the various parts of the Province.

8. A prominent feature is made of Bills and Accounts, and of money transactions generally, including an exercise on the making of Change.

9. There are over 500 problems on four simple rules based on the Practice Table, the answers to which appear only in the teacher's edition.

10. There are 576 self-testing exercises in long division.

Problems in Arithmetic

FOR

II. and III. BOOK CLASSES.

EDITED BY

W. E. GROVES,

Principal Church Street School, Toronto.

Edition with Solutions and Answers (Teachers only), 50c.
Edition without Answers (Scholar's Edition), - - 25c.

TEACHERS STRONGLY RECOMMEND THEM.

The best I have seen.—SAM. J. LATTER, *Principal Public School, Zurich.*

Shall introduce immediately.—M. A. STEWARD, *Principal Public School, Lancaster.*

Recommend it.

The problems are excellent, and I hope the book may meet with the favor it merits. I would recommend it to busy teachers.—AMY H. GUTHRIE, *Teacher, Port Credit.*

Unprecedented in the history of Arithmetics.

The plan and matter of "Problems in Arithmetic for Junior Classes" by W. E. Groves, are unprecedented in the history of Arithmetics. The careful grading and the absence of answers in Scholars' Edition make it especially useful to teachers in ungraded schools. Mr. Groves is highly practical and logical.—E. R. WITHERIL, *Prin. Westport P.S.*

The best I have seen.

The Problems in Arithmetic for II. and III. Book Classes are the best I have seen.—SAM. J. LATTA, *Zurich.*

Save time and labor.

The Arithmetic will save the teachers time and labor and will prove valuable educationally as it contains a great variety of problems.—W. H. BAKER, *Bayfield.*

Shall introduce it immediately.

I am so pleased with the Arithmetical Problems for II. and III. Classes, by W. E. Groves, that I shall introduce it into our school immediately. I hope the IV. Class work may be equally good.—W. A. STEWART, *Prin. P.S., Lancaster.*

Highly Pleased with them.

I have made a careful examination of your Problems for II. and III. Book Classes and am highly pleased with them. The arrangement of the problems is the best I have seen in any book of its kind. —SAM. M. HAUCH, *Principal P.S., Dashwood.*

Problems in Arithmetic

FOR

IV. BOOK CLASSES.

EDITED BY

W. E. GROVES,

Principal Church Street School, Toronto.

Edition with Answers (for Teachers only) - - - 50c.
Edition without Answers (Scholar's Edition) - - 25c.

TEACHERS STRONGLY RECOMMEND THEM.

Will save much valuable time of busy teachers.—H. S. BOLITHO, *Prin. Mattawa District Training Institute.*

Plan and matter is unprecedented in the history of arithmetics.—E. R. WITHERIL, *Principal Westport P.S.*

I am very much pleased with it.

I am very much pleased with it. I find them very useful for forming a test of the pupils knowledge apart from the text book.—M. N. WALLACE, *Prin. Hepworth P.S.*

Saves valuable time.

I find after carefully looking over the work that the problems are practical and its use will save much valuable time for the teachers of junior classes.—H. J. BOLITHO, *Principal Mattawa District Training Institute.*

Delighted with it.

I handed over your copy of Groves' Problems to my assistant and she is delighted with it.—F. H. EATON, *Delta.*

Really excellent.

They are really excellent, no school should be without them.—A. M. DAVIDSON, *H. M., Public School, Bronte.*

Intend to have it introduced.

I intend to have it introduced here, and used as much as possible, as I like it very much.—ROBERT W. BRIGHT, *Prin. Drayton P.S.*

Much pleased with its contents.

I am much pleased with its contents, with the neatness of its appearance and the compactness of its make-up. The "busy problems" are excellent for the drill which they give the pupils, and the facility with which they may be examined by the teacher. The book must prove a help to all young teachers —and there are many of us.—R. A. WARD, *Prin. Keene P.S.*

The best out.

The Arithmetic is admirably adapted for junior classes. I must say it is the best out.—J. D. NICOL, *Eganville P. S.*

Prize Problems in Arithmetic.

Selected and arranged by W. H. BALLARD, M.A., Inspector of Schools, Hamilton, and W. J. ROBERTSON, B.A., LL.B., Mathematical Master, St. Catherines' Collegiate Institute. There are about 1,100 Problems in this book of which about 500 are from Prize Problems contributed to the *Canada School Journal*. The object of the book is to place in the hands of teachers and pupils a careful selection of Problems suitable to the fourth class in our public schools, thus enabling them to prepare thoroughly for entrance examinations to high schools and collegiate institutes. The selection is particularly strong in interest and percentage. 10th edition. Price 20 cents.

Decidedly a help.

Will be decidedly a help to teachers who are preparing pupils for the entrance examinations to high schools The Problems cover a wide field, and are, most of them, eminently practical.—J. A. WISMER, M.A., *Head Master, Parkdale.*

Interesting and practical.

I find the questions in the various departments of Arithmetic presented in great variety, and at once interesting and practical.—J. A. MACPHERSON, *Head Master, Beeton P.S.*

Excellent for home work.

Your "Prize Problems in Arithmetic" contains a great number of excellent Problems for home work or examinations.—J. S. ROWAT, *P.M.S., Caledonia.*

Intend introducing it.

I intend introducing it in my fourth-book class at the beginning of the term. It will make an excellent review book.—M. P. MCMASTER, *Principal P.S., Thorold.*

More than pleased.

I am more than pleased with it.—THOS. HAMMOND, *Head Master, P.S., Aylmer.*

Comprehensive and very practical.

The problems are definitely worded, comprehensive in range, and very practical.—J. C. MUNRO, *Principal P.S., Palmerston.*

Will use it.

I will endeavor to have my class of next session provide themselves with the work.—A. N. THORNTON, *Head Master, P.S., Wallaceburg.*

Best of the kind.

I consider it the best of the kind that I have seen.—J. C. STEWART, *Principal Pembroke P.S.*

An indispensible help.

I have thoroughly examined "Prize Problems in Arithmetic," by Robertson and Ballard, and believe teachers will find it an indispensible help. — JAS. DUNCAN, *Prin. Essex Model and Windsor Central Schools.*

Time and labor saving.

The questions are practical and will induce a wider range of thought. Any teacher using this work will find it both time and labor-saving in reviewing for examinations. — M. H. THOMPSON, *Principal Aurora P.S.*

Shall introduce the book.

The problems involving interest and percentage are very numerous, and include an almost endless variety of application. I shall introduce the book to our entrance class.—W. E. GROVES, *Principal P.S., Wingham.*

Useful to teachers and pupils.

I feel certain that the work will not only be interesting, but also very useful to both teachers and pupils.—T. O. STEELE, *P.M.S., Barrie.*

Hamblin Smith's Arithmetic.

A treatise on Arithmetic by J. Hamblin Smith, M.A., of Gonville and Caius College, and late lecturer at St. Peter's College, Cambridge. Adapted to Canadian schools by Thos. Kirkland, M.A., Principal Normal School, Toronto, and Wm. Scott, B.A., Mathematical Master, Normal School, Ottawa. Eighteenth edition. Price 60 cents.

Authorized for use in the Schools of Ontario.
Authorized for use in the Schools of Quebec.
Authorized for use in the Schools of New Brunswick, 1892.
Authorized for use in the Schools of Prince Edward Island.
Authorized for exclusive use in the Schools of Nova Scotia.
Authorized for exclusive use in the Schools of Manitoba.
Authorized for exclusive use in the Schools of British Columbia.
Authorized for exclusive use in the Schools of Newfoundland.

Kirkland & Scott's Arithmetic.

An Elementary Arithmetic on the Unitary System intended as an introductory text book to Hamblin Smith's Arithmetic, by Thos. Kirkland, M.A., Principal Normal School, Toronto, and Wm. Scott, B.A., Mathematical Master, Normal School, Ottawa. Three hundredth thousand. Price 25 cents.

Authorized for exclusive use in the Schools of Nova Scotia.
Authorized for exclusive use in the Schools of Manitoba.
Authorized for exclusive use in the Schools of British Columbia.
Authorized for exclusive use in the Schools of Newfoundland.
Authorized for use in the Schools of Quebec.
Authorized for use in the Schools of Ontario (prior to issue of Government Text Book).

Kirkland & Scott's Arithmetic, French Edition.

Edited by U. E. Archambault, Superintendent of French Schools, Montreal. For use in French schools. Price 25 cents.

Key to Hamblin Smith's Arithmetic.

Or the solution of the most difficult exercises and examination papers in the Canadian edition of Hamblin Smith's Arithmetic, by Thos. Kirkland, M.A., Principal Normal School, Toronto, and Wm. Scott, B.A., Mathematical Master, Normal School, Ottawa. Prepared for the use of private students and teachers. Price $2.00.

Revised Edition Gage's New Map Geography Primer. Price 40 cents.

For Pupils preparing for Promotion Examinations.

For Pupils preparing for Entrance Examinations.

For Pupils preparing for Junior and Senior Leaving Examinations.

For Pupils reviewing for Certificates or Final Examinations.

TO overcome the great difficulty of preparing students for these examinations, some masters throughout the province have taken the ordinary text-books in use, and from the multitude of sentences, selected what they deemed necessary to be learned by the pupil. Others again have used the blackboard or the dictation book for the facts to be memorized. These plans are objectionable, as the one does not present the words from the text-book so as to be remembered readily, and the others necessitate the loss of much valuable time. Further, the pupil does not recognize the word in its written form, and thus the spelling is not taught. Of still more importance and what in itself should commend the work to teachers and the public generally, is that *the exercise book required for the dictation exercises* in Geography alone *costs as much as this primer.*

The work is arranged in tabular analysis, to prevent the waste of time in poring over a prosy text-book. Brief notes are inserted at intervals to convey information of special interest. Although merely preliminary, this book will be found to contain all that is necessary to fit a student for any of our examinations in the subject, Geography.

As to *what* and *how much* to teach, those in charge must exercise their own judgments.

The attention of both teacher and student is directed to the Railway Map and to its analysis as special features of the book.

The new matter thus added relates to such interesting portions of the earth as Australia and parts of Oceania, Africa, the West Indies, and Central America. These places, containing as they do sister colonies, claiming a common origin with ourselves from British stock, cannot fail to be of deep interest to all loyal Canadians.

The statistics of the various countries, particulary those speaking the English Language, have been brought down to the latest date; this is possible at this juncture owing to the prevailing custom of taking the census every decade.

Revised Edition Gage's New Map Geography Primer.

The Railway map and letter press instruction accompanying it, which forms a special feature of the work, is also brought down to latest date, and will be found to almost furnish a "travellers' guide," as nearly every place of importance will be found therein. It will be noticed that the older parts of Canada are as well supplied with railway facilities as any part of the world. The natural products, manufactures, trade and commerce, have received special atttention; and, while not claiming that it contains everything essential to a complete knowledge of Geography, it is contended that as much useful information has been packed into the limited space as is either wise or prudent.

The Main Features may be summarized as follows:—

Brief and Clear.—The whole matter is put in so brief and clear a manner that the time of teachers and pupils will be saved and most satisfactory results can at the same time be secured.

Complete.—It is believed that this new Primer contained all that is necessary to cover Promotion, Entrance, Junior and Senior Leaving Examinations.

Its Utility—Time Saved, Expense Saved.—Instead of the teachers marking in the large text-books the lessons to be learned, or using blackboards or dictation books, the student has presented in this little Primer in clear concise form all that is necessary to be remembered.

Maps.—Fifteen beautiful maps are inserted, namely: Map of the World, Western Canada, Dominion of Canada, North America, South America, United States, Europe, England, Scotland, Ireland, Asia, Africa, West Indies and Central America, Mexico and Australia. Map of Geographical terms.

Among the special features of the new edition will be noted:

New Railway Map.—The Grand Trunk Railway System is indicated by a Red Printing and Canadian Pacific Railway indicated by a Green Printing, thus showing at a glance these two great Railway Systems of Canada.

New Maps of West Indies, Central America and Mexico have been added, also a map of the Dominion of Canada showing · ative relations of the different Provinces of Canada.

Revised Edition Gage's New Map Geography Primer.

New Double Page Map of Ontario.—Printed from relief plates in three colors with all of the most recent information available.

New Double Page Map of British Columbia brought down to date.

Double Page Map of Quebec.

New Statistics of various countries have been inserted, giving information to latest date in accordance with the recent census, in which Products, Manufactures, Trade and Commerce have received special attention.

A Chapter on Topical Geography for Language Lessons.

Specimen Promotion Examination Papers.

Price.—Notwithstanding the book has been printed on beautifully calendered paper, entirely re-written with a large number of additional maps, the price remains the same, viz., 40 cents, and is about one-half of that of ordinary texts books.

County Editions have been issued, the Counties being grouped together and beautifully engraved maps of each County, with every post-office, population of villages, towns, etc., and other useful information supplied.

CONTENTS OF COUNTY MAPS.

Each map marks the location of every post-office, shows the population of each village or town, shows the location of telegraph stations, the main travelled roads and the distances between stations on the various lines of railway.

County Edition A.

With County maps of Essex, Kent, Lambton, Middlesex, Elgin, Perth, Huron.

County Edition B.

With County maps of Oxford, Norfolk, Brant, Wentworth, Haldimand, Lincoln, Welland, Waterloo.

Revised Edition Gage's New Map Geography Primer.

County Edition C.

With County maps of Halton, Peel, York, Dufferin, Wellington, Simcoe, Grey, Bruce, also double page map of the City of Toronto.

County Edition D.

With County maps of Ontario, Durham and Northumberland, Peterborough, Haliburton, Victoria, Hastings, Prince Edward, Lennox and Addington.

County Edition E.

With County maps of Frontenac, Leeds and Grenville, Russell and Prescott, Renfrew, Lanark, Carleton, Dundas, Stormont and Glengarry.

Gage's Map Geography--Quebec Edition.

Contains a large double page map of the Province of Quebec, also map of the Eastern Townships, together with additional Text descriptive of the Province of Quebec. Price 40 cents.

Gage's Map Geography--Manitoba Edition.

Contains double page map of Manitoba, together with the descriptive text of that Province revised up to date. Price 40 cents.

Gage's Map Geography--British Columbia Edition.

Contains new double page map of British Columbia, together with descriptive text revised to date. Price 40 cents.

Recently Authorized by the Board of Education for use in the Schools of British Columbia.

GAGE'S NEW MAP GEOGRAPHY PRIMER.

"The saving of time, the awakening of interest and the final attainment of success will be realized, I believe, in every case where it is used."—J. A. HILL, PH.B., *Headmaster Dundas Public School.*

Consider it excellent.

It is quite an improvement on the old edition and contains an immense amount of information for such a small book. The maps I consider excellent.—A. DORSET, *Essex, Ont.*

Greatly improved.

I have carefully examined your New Map Geography Primer and find it enlarged and greatly improved. The type, paper, binding and maps are all excellent. Teachers will find that it is now one of the best works on the subject for junior classes.—T. B. CASWELL, *Principal Public School, Carleton Place.*

Decided improvement.

This new edition of Map Geography is a decided improvement on the old.—L. H. LUCK, *Penetang.*

Many praiseworthy additions.

The Map Geography is now so well known to the teachers of Ontario, that it requires no extra commendation from me. The edition of '92 has many praiseworthy additions, and is one of the handiest little books for the school-room that I know of.—WILL. J. HAMILTON, *Principal Public School, Campbellford.*

Extremely useful.

Your enlarged and revised Geography Primer is a credit to your enterprise. I find it extremely useful as a supplement to the Text-Book.—E. J. ROWLANDS, *Head Master, Model School, Caledonia.*

Recommend it.

I have used your Map Geography and recommend it to my pupils, many of whom use it, in preparing their lessons, and with good results. —ROBERT W. BRIGHT, *Drayton, Ont.*

Recommend its use.

Your New Map Geography contains a large amount of information, well arranged and suitable for students preparing for the various official examinations. I shall recommend its use.—C. S. FALCONER, *Principal District Training School, Algoma.*

The best out.

The Geography I must say is the best out.—J. D. NICOL, *Eganville P. S.*

Find it excellent.

I have examined your New Map Geography Primer (Revised Edition) and find it excellent. The beautiful new maps, latest statistics, and especially the new railway map of Ontario, are features that should commend it to teachers. —J. A. REEDER, *Principal Blenheim P. S.*

An invaluable work.

The labor of acquiring a great deal of valuable geographical knowledge is so facilitated in your Map Geography Primer as to render it an invaluable work, not only for the school-room but for the home.—R. H. KNOWLES, *Pricipal Hespeler Public School.*

Recently Authorized by the Board of Education for use in the Schools of British Columbia.

GAGE'S NEW MAP GEOGRAPHY PRIMER.

"By using it a great deal of time is saved."—JAMES P. WESTMAN, *Prin. Crediton P.S.*

Well pleased with it.

I have carefully examined the New Map Geography Primer, and I was so well pleased with its appearance and contents that I lost no time in showing it to my Entrance Class, recommending it to them as the best of its kind for their work. It is now in the hands of nearly every member of the class for use at home, and the pupils are delighted with it.—S. C. WOODWORTH, *Principal Model School, Welland.*

Highly delighted.

I am highly delighted with your Map Geography Primer.—A. A. MCLEAN, *Mar, Ont.*

Most useful help.

I consider your New Map Geography Primer one of the most useful helps to both teacher and student. The statistics are up to date. This feature alone, to say nothing of the mass of other information, Railroad and County Maps, and scores of graded Examination Questions, should give it a place on every public school teacher's table. I have used your old Map Geography Primer for years and would not be without such a book. The new edition is quite an improvement on the old.—W. A. GRAHAM, *Prin. Oil Springs P.S.*

Already Used.

Many of my pupils already use the Map Geography.—L. F. HARROP, *Prin. Niagara Falls P.S.*

Pleased with many features.

I am highly pleased with many features of your new Map Geography Primer.—THOS. HAMMOND, *H.M., Aylmer P.S.*

Will recommend them.

I will recommend it to those of my assistants who teach geography.—A. MCKEE, *Head Master, Uxbridge P.S.*

Useful matter.

The Geography contains a great deal of useful matter not easily found elsewhere.—W. H. BAKER, *Bayfield.*

Good Maps and concisely arranged information.

The Geography contains good maps and a great deal of concisely arranged information. — H. R. LONGH, *Principal Model School, Clinton.*

A perfect work.

The new Geography Primer should be in the hands of every teacher and pupil who wish the greatest amount of information in the shortest time. For review for examination it is a perfect work. The Railway Map alone is worth more than the price of the book. I should like to see it extensively used.—B. C. H. BECKER, *Prin. Brighton P.S.*

Is pleased to see them used.

I am pleased when I see your Map Geography Primer in the hands of my pupils. Some of them are using them with the regular text-books.—G. E. HENDERSON, *Prin. Kingsville School.*

Very much improved.

I consider the Revised Edition of your Map Geography Primer very much improved and shall recommend it to my students.—J. W. LAND, *Principal P.S., St. Marys.*

Gage's New Topical English and Canadian History Notes.

This little Primer is prepared to cover the Public School History Course in English and Canadian History, and is printed so as to furnish a number of blank leaves to allow students to make additional notes. Price 25 cents.

Leading Features.

1. The Notes are arranged Topically under such headings as best indicate the True Growth of the nation.
2. The Progress of the People, the Struggle for Freedom, the Establishment of Representative Government, and the Development of Education, Literature and Religion, are given more prominence than wars.
3. The Colonial Extension of the British Empire is briefly outlined.
4. The whole History is Classified, so that the Relationships of the Great Upward Movement can be understood.
5. The arrangement of the Notes makes it Easy, Definite and Thorough Reviewing, perfectly simple without a teacher.
6. The Notes supply an Admirable Preparation for the study of larger histories, and the best means for Clearly Remembering what has been learned from them.
7. Ample space has been left for Additional Notes, to be written by the student.
8. The Notes can be used in connection with any History, and are intended to Stimulate the Further Study of the important subject with which they treat.

By the use of this Note Book

1. Time is Saved to teachers and pupils.
2. Success at Examinations made more certain.
3. Interest is Awakened in the study of History.
4. A simple, definite Method of Studying History is revealed.

GAGE'S

English & Canadian History Note Book.

From **PROF. WILLIAM CLARK, M.A., LL.D.,**

Trinity College, Toronto.

"It is an admirable compilation, equally useful to lecturer and student, and I am very glad to peruse it. I shall often refer to it."

A long-felt want.

Your English and Canadian History Notes fill a long-felt want. There seems to be no text book at present suitable for junior pupils, and the notes will save the teacher much time in arranging class work. They are just the thing for oral teaching and review, and may be used with any English or Canadian History.—W. A. GRAHAM, *Prin. Oil Springs P.S.*

A very great aid.

Your Notes on English and Canadian History will meet the needs of many teachers who are pressed for time. Entrance pupils will find it a very great aid.—L. F. HARROP, *Prin. Niagara Falls P.S.*

Admirably adapted.

It is admirably adapted for Entrance classes, and will make the work definite and thorough.—S. Y. TAYLOR, *Prin. Public School, Paris.*

Just the thing.

I am pleased when I see your "English and Canadian History Note-book" in the hands of my pupils. Some of them are using them with their regular text-books and find them just the thing.—G. E. HENDERSON, *Principal Public School, Kingsville.*

Great help to students of history.

I have examined your Canadian and English History Note Book, and, although I am somewhat prejudiced against Note Books of any kind, I must say that yours is the best and most carefully selected Notes that I have seen come from the press, and under the care of a judicious teacher they must be a great help to students of history.—THOS. HAMMOND, *H.M. Aylmer P.S.*

Grasping points supplied.

The History Notes, I am sure, cannot fail to meet the approval of teachers, especially in the public school, where the leading events of Canadian and English History are required. This little book is admirably adapted to the needs of the teacher, since History can be taught to young pupils only by providing them with grasping points whereby they may retain the hold they get during a lesson, and your book supplies those points.—A. H. KILMAN, *Ridgeway P.S.*

Fill an important niche in review.

I expect to find the Notes on History fill an important niche in the review lessons on that subject.—D. M. WALKER, M.A., *Head Master, Prescott.*

Gage's English and Canadian History Note Book.

"I have seldom had one plucked in history after using this book." — ROBERT W. BRIGHT, *Principal Public School, Drayton.*

Just what I have been looking for.

The History is something excellent—just what I have been looking for. I intend to have all my Entrance pupils get them.—SAM. J. LATTA, *Zurich.*

Both convenient and helpful.

I think it well suited for the purpose for which it is intended. The busy teacher, and in fact any teacher, who has the subject in hand, will find the notes both convenient and helpful in preparing his lesson and in assigning home work.—A. MCKEE, *Head Master, Uxbridge P.S.*

Great assistance to the teacher

The History will be of great assistance to the teacher in preparing his notes. The topics are well chosen and the book is a good outline of the subject.—H. R. LONGH, *Prin. Model School, Clinton.*

Pleased with the arrangement.

I am particularly pleased with the arrangement of the topics in the English and Canadian History Note Book. It will greatly aid teachers in saving time, and all candidates preparing for examination—from promotion to senior leaving. It is an eminently practical work.—B. C. H. BECKER, *Prin. Brighton P.S.*

Will save time.

It will save the teacher as well as the pupils a great amount of valuable time. With present text book on History, pupils require an encyclopædia and an unabridged dictionary to arrive at the meaning of the language.—J. G. CARRUTHERS, *Prin. Cayuga P.S.*

Probable it will be adopted in the North-west.

I believe it is well adapted to the use for which it is intended. I shall pass it to some of the other teachers interested in the subject, and it is probable it will be adopted in one or more classes of our school.—W. J. CHISHOLM, *Member of the Board of Education for the N.W.T.*

An excellent supplement to High School History.

An immense saving of time is afforded by the use of Gage's New English and Canadian History Note Book. An excellent supplement to High School History. Plan unsurpassed.—E. R. WITHERIL, *Prin. Westport P.S.*

Will do away with writing notes.

The use of your History Note Book will do away with the writing of elaborate history notes that we have always had. The blank space leaves room for each teacher's individuality to show in placing his own special, and to him important, notes along side of your general ones.—W. A. STEWART, *Prin. P.S., Lancaster.*

Have never met any work to equal it.

I am highly pleased with your History Primer. I have never met any work to equal it for the intended purpose. So far as I am personally concerned I find it a wonderful assistance in presenting historical facts to my pupils in a satisfactory and telling manner.—J. A. HILL, PH. B., *Headmaster Dundas Public School.*

Gage's Practical Speller.

Authorized by the Council of Public Instruction, Quebec.
Authorized by the Council of Public Instruction, Manitoba.
Authorized by the Council of Public Instruction, British Columbia.
Authorized for use in the Schools of North-West Territories.
Authorized for use in the Schools of New Brunswick.
Is used in a number of the best Schools of Ontario.
Is used largely in the Province of Nova Scotia.

A series of graded lessons suitable for high and public schools. with words in general use, with abbreviations, etc., words of similar pronunciation and different spelling, a collection of the most difficult words in the English language, and a number of literary selections which may be used for dictation lessons and committed to memory by the pupil, together with Latin and Greek roots, affixes and prefixes most frequently found in the Public School Reader. 100th thousand. Price 30 cents.

THE old-fashioned Spelling book has been discarded by teachers generally. Many valid objections were properly urged against its use and it passed away.

Entire dependence upon *oral spelling* may also be fitly styled a method of bye-gone days. Unfortunately for the old spelling book, it was associated with all the folly and weakness of "oral spelling," and this partly accounts for its rejection.

What have the reformers given as a substitute for a speller? They took our bread and have given in return but a stone. The bread, even though a little stale, was much more wholesome than the stone. In Canada, parts of the lessons to be found in the Readers are taken as dictation lessons, and the pupils are turned loose on society to shock it by their bad spelling, and disgrace the schools which they attended and in which they should have been taught. The Readers do not contain all the words boys and girls will have to spell in life, and if they did, the lessons are not arranged in proper form for spelling lessons. Only a comparatively small portion of the Readers can be written from dictation in school. Bad as were the old spellers they were infinitely better than nothing. This fact is now recognized in Great Britain and the United States, in both of which countries many valuable spelling books have recently been issued. That these were necessary in England is clearly shown by the fact that at a recent Civil Service Examination "no less than 1,861 out of 1,972 failures were caused by bad spelling."

A practical dictation Speller is clearly a necessity, and this work has been prepared to supply an obvious want in the programme of Canadian schools. The claim to the name "practical" is based on the fact that it is not a mere collection of thousands of "long-tailed words in *osity* and *ation*," but contains a graded series of lessons to teach the pupils the proper spelling of the words all have to use.

Gage's Practical Speller.

A superior little work.

The "Practical Speller" is a superior little work, and should find its way into every public school. The plan is ingenious and for aught I know may be original.—J. S. Carson, *Inspector P.S., Strathroy.*

Just what is wanted.

The "Practical Speller" appears to be just what is wanted.—Rev. W. Pilot, *Supt. Church of England Schools, St. Johns, Newfoundland.*

Particularly pleased with it.

I am particulary pleased with the arrangement of exercises and the choice of words in every-day use, as well as the high character of many of the literary selections. As a hand book both for oral spelling and dictation, the book merits a place in every school. — G. D. Platt, B.A., *Inspector P.S., Picton.*

Very suitable.

"It is very suitable for the object in view."—*Canada Presbyterian.*

Is a necessity.

"The 'Speller' is a necessity and we have seen no book which we can recommend more heartily than the one before us."—*Presbyterian Witness, Halifax.*

Correct blending system.

As a rule masters follow only the dictation plan, hence there can be little doubt that the notoriously bad spelling on the part of the most students of the present day is due to a neglect of the *oral* method. A correct blending of the two systems is arrived at in this work.—Sam. Hughes, *Toronto Coll. Inst.*

Well pleased with it.

I am well pleased with it. I endorse every word in the preface. I would like to see it introduced in every school.—N. M. Campbell, *II.M., Co. Elgin Model School.*

No rules.

Among the many advantages this text-book possesses above all others with which I am familiar, is the noteworthy fact that it contains *not a single rule for spelling.*—W. D. Mackenzie, M.D., *I.P.S., Parrsboro, N.S.*

Simplicity.

The "Practical Speller" in an admirable work; its arrangement and simplicity commend itself to all teachers as a text-book, and to all others who are desirous of acquiring a thorough knowledge of this most important branch of education. —J. H. Forde, *H.M., Central School, Sherbrooke, Que.*

Admirable work.

I consider it an admirable little work. The chapter on Similar Sounds is a particularly valuable one.—Howard Murray, *Prin. Academy, New Glasgow, N.S.*

Recommends it.

I am much pleased with it. I like the plan of grading the lessons, and also the classing of words pertaining to certain trades, professions, etc. I have found it very useful in dictation exercises. Have recommended it to several teachers.—E. J. Lay, *Prin. Academy, Annapolis, N.S.*

Combination of excellencies.

The grouping of words in common use, the reviews, the dictation exercises and literary selections are all admirable, and form a combination of excellencies not surpassed in any book of the book of the kind that I have ever met with.—A. C. A. Doane, *I.P.S., Barrington, N.S.*

Excellent work.

I can truly say I think it a very excellent work. The preface is very valuable both for teachers and pupils, and if it could be generally introduced into our schools, I have no doubt that the results would be satisfactory.—Prof. J. F. Tufts, *Wolfville Colleqe, N.S.*

490
2450
490
706
68040
3024
73) 370440 (
360
24

365 x 27

13610
16338
8460
4) 986895
246724
2450